United States General Accounting Office

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Report to Congressional Requesters

July 2000

DEFENSE ACQUISITIONS

Comprehensive Strategy Needed to Improve Ship Cruise Missile Defense

GAO

Accountability * Integrity * Reliability

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Contents

Abbreviations

ACDS	Advanced Combat Direction System
AIEWS	Advanced Integrated Electronic Warfare System
AOE	fast combat support ship
CC&D	Common Command and Decision
CEC	Cooperative Engagement Capability
DOD	Department of Defense
ESSM	Evolved Sea Sparrow Missile
GMFCS	Guided Missile Fire Control System
GMLS	Guided Missile Launching System
HAS	helicopter/aircraft/surface craft
IRST	Infrared Search and Track
LHA	Landing Helicopter Assault Ship
LPD	Amphibious Transport Dock Ship
LSD	Dock-Landing Ship
MFR	Multi-function Radar
MPU	Medium Pulse Repetition Upgrade
NATO	North Atlantic Treaty Organization
NSSMS	NATO Sea Sparrow Surface Missile System
NULKA	Offboard Active Decoy
RAIDS	Rapid Anti ship Cruise Missile Integrated Defense System
RAM	Rolling Airframe Missile
RNSSMS	Rearchitectured NATO Sea Sparrow Surface Missile System
SM	Standard Missile
SSDS	Ship Self Defense System
TISS	Thermal Imaging Sensor System
VSR	Volume Search Radar

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United States General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-283202

July 11, 2000

The Honorable Curt Weldon
Chairman
The Honorable Owen B. Pickett
Ranking Minority Member
Subcommittee on Military
Research and Development
Committee on Armed Services
House of Representatives

Since the end of the Cold War, the U.S. Navy has shifted its focus from preparing for warfare on the open ocean to developing operational concepts and capabilities for conducting combat operations in the coastal waters of the world. However, the proliferation of increasingly sophisticated anti-ship cruise missiles threatens the ability of Navy ships to operate and survive close to hostile shores. In response to this threat, the Chief of Naval Operations directed a comprehensive review of ship self-defense requirements. Completed in fiscal year 1996, this study formally identified the capabilities needed by each ship class[1] to defend against cruise missile threats in the near, mid-, and far term.[2] Since then, the Navy has spent $3.8 billion to improve its ship self-defense capabilities against cruise missile attacks, and it plans to spend another $5.1 billion over the next 6 years.

This report responds to your request that we (1) assess the Navy's progress since 1996 in improving the self-defense capability of surface ships against cruise missiles and (2) evaluate Navy plans for meeting future anti-cruise missile self-defense requirements. Appendix I contains the specific information you requested on the planned defensive suite for the San Antonio class of amphibious ships now in development.

[1]The ship classes for which self-defense performance requirements were established include aircraft carriers (CV and CVN); Aegis cruisers and destroyers (CG-47 and DDG-51 classes); Spruance destroyers (DD-963 class); frigates (FFG); amphibious ships (LHA, LHD, LPD-17, and LSD 41/49); and fast combat support ships (AOE).

[2]The Navy study defined the near term as 1998-2005, the mid-term as 2006-2011, and the far term as 2012 and beyond.

Results in Brief

Although the Navy has made some progress in improving surface ship self-defense capabilities, most ships continue to have only limited capabilities against cruise missile threats. A Navy assessment of current surface ship self-defense capabilities conducted in 1998 concluded that only the 12 Whidbey Island and Harpers Ferry class amphibious ships have or will be equipped with defensive systems that can provide measurable improvement against near- and mid-term cruise missile threats. The assessment projected that none of the improvements the Navy plans to make in the future would provide any ship class a high level of self-defense capability against far-term threats. In projecting ship self-defense capability improvement, the assessment assumed, among other things, that all planned improvements would be developed and fielded as scheduled. We believe that the Navy assessment overstates the actual and projected capabilities of surface ships to protect themselves from cruise missiles because the models used in the assessment to determine capabilities include a number of optimistic assumptions that may not reflect the reality of normal fleet operations. Among these assumptions are perfect weather, uninterrupted equipment availability, and perfect crew and equipment performance at all times. Further, inadequate funding, maintenance, and repair parts support continue to limit the availability of existing self-defense equipment.

Plans for meeting ship self-defense requirements are not promising because the Navy still does not have a comprehensive and consistent strategy for improving its capabilities. Previous plans have not included all affected ship classes, have not always established priorities among ship classes, have not consistently used a baseline from which to measure progress, and have not provided timelines for achieving the desired improvements. Although Navy leaders express concern about the vulnerability of surface ships, that concern may not be reflected in the budget for ship self-defense programs. From fiscal years 1997 to 2005, spending is relatively flat (fluctuating between $719 million and $1 billion) and associated research and development funding is projected to decline from about $517 million to about $218 million.

This report contains a recommendation to the Secretary of Defense to direct the Secretary of the Navy to develop a comprehensive strategy for self-defense improvements for surface ships that clearly articulates priorities, establishes baselines, provides timelines, and defines resource requirements for achieving needed improvements. The Department has agreed with the recommendation and plans to request that the Navy develop a comprehensive strategy within 30 days after the release of the our report.

Background

The threat to surface ships from sophisticated anti-ship cruise missiles is increasing. Nearly 70 nations have deployed sea- and land-launched cruise missiles, and 20 nations have air-launched cruise missiles. There are over 100 existing and projected missile varieties (including subsonic[3] and supersonic,[4] high and low altitude, and sea-skimming models) with ranges up to about 185 miles. Table 1 shows some of the current and projected missile threats.

Table 1: Anti-ship Cruise Missile Threats

Missile type	Producing country	Approximate range in miles	Speed
Existing and near-term threats (1999-2005)			
C801	China	25	Subsonic
C802	China	65	Subsonic
Enhanced Harpoon	Israel	75	Subsonic
Exocet	France	45	Subsonic
Moskit	Russia China	55–75	Supersonic
Uran	Russia	80	Subsonic
Yakhont	Russia	185	Supersonic
Novator Alpha	Russia	125	Subsonic missile with supersonic terminal phase
Projected mid- and far-term threats (2006 and beyond)			
C701	China	10	Subsonic
Teseo 3	Italy	185	Subsonic

Source: Defense Intelligence Agency and Office of Naval Intelligence.

[3]Subsonic is less than the speed of sound (i.e. around 742 miles per hour).

[4]Supersonic is greater than the speed of sound.

Current anti-ship cruise missiles are faster, stealthier, and can fly at lower altitudes than the missiles that hit the U.S.S. *Stark* in 1987, killing 37 sailors (see fig. 1). The next generation of anti-ship cruise missiles—most of which are now expected to be fielded by 2007—will be equipped with advanced target seekers and stealthy design. These features will make them even more difficult to detect and defeat.

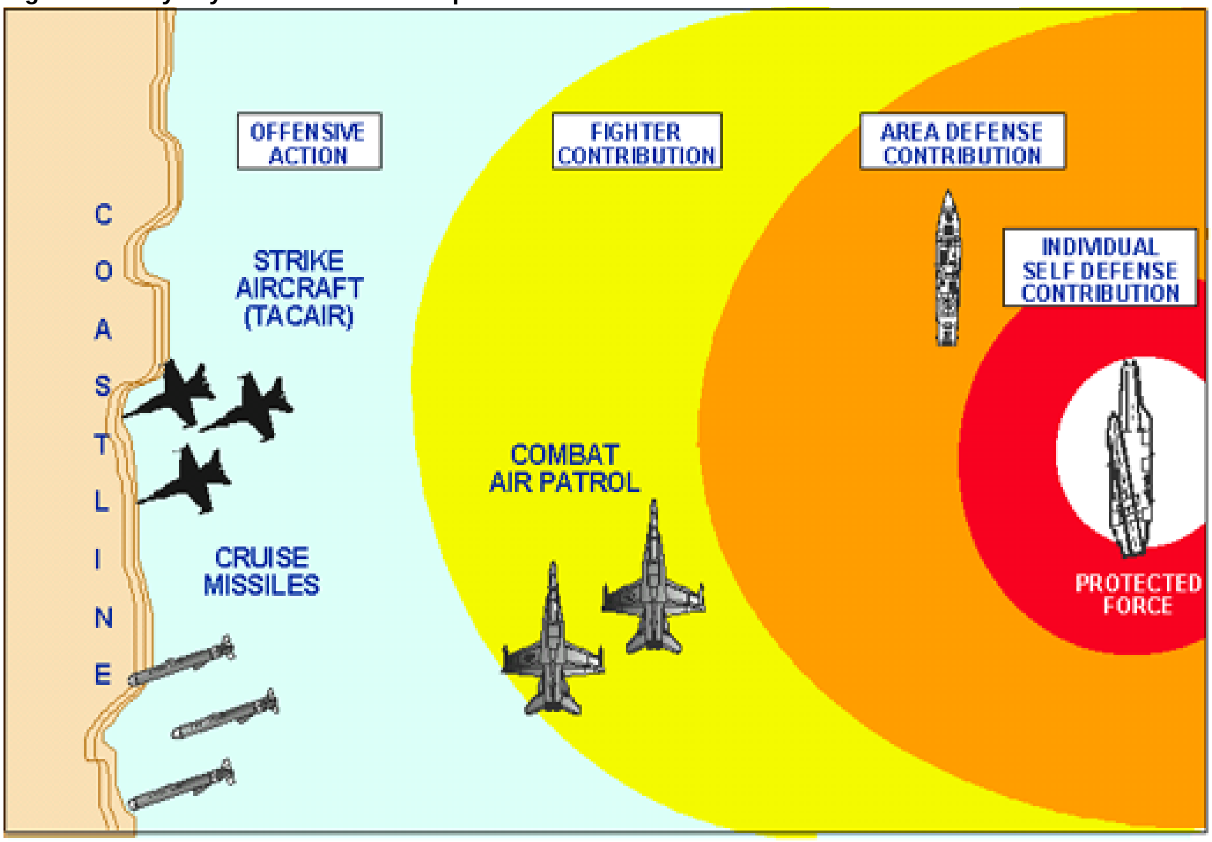
Figure 1: U.S.S. *Stark*, 1987

Source: Department of Defense.

Defeating modern cruise missiles involves three distinct phases: detection, control, and engagement. In the detection phase, sensors aboard ships and aircraft attempt to detect and track incoming cruise missiles. In the control phase, ships' computers and software identify and evaluate approaching threat missiles. In the engagement phase, threat missiles are further evaluated, prioritized, and assigned to an appropriate weapon system for destruction. Decoys or electronic countermeasures may be employed first, with missiles and guns fired against the threat missiles when they come within range.

For operations involving a large number of ships, such as a carrier battle group, the Navy intends to use a layered defense to defeat hostile cruise missiles, as illustrated in figure 2 below. In high-threat situations, where multiple, simultaneously launched missile threats are expected, fighter aircraft, cruisers, and destroyers are responsible for providing the outermost defenses. The Navy assumes that these assets will be able to significantly reduce the number of missiles directed against a battle group, but it recognizes that some missiles could be fired and get through the outer defenses. Therefore, individual ships must have an autonomous capability to defend themselves. In peacetime presence or interdiction operations, individual ships are often required to operate independently, without the protection of the layered defenses provided by a battle group. Consequently, they must be able to rely on their own self-defense capabilities.

Figure 2: Navy Layered Defense Concept



Source: U.S. Navy.

In 1995, the Chief of Naval Operations directed a comprehensive review of ship self-defense requirements. In conducting this analysis, the Navy defined requirements for three basic operational situations—contested, uncertain, and controlled[5]—that its surface ships may encounter in the post-Cold War era. The review also assessed the expected threat levels and the degree to which layered defense assets contributed to an individual ship's self-defense capabilities. The review defined the level of defenses needed by individual ship classes in the three operational environments using the Probability of Raid Annihilation (PRA) model.[6] The Chief of Naval Operations approved the identified levels of needed capability and the Navy formalized them in the Self-Defense Capstone Requirements document in February 1996. Since then, the Navy has been attempting to develop and field defensive systems that would enable each ship class to achieve the required level of self-protection.

Existing and Projected Defense Capabilities Are Limited

The Navy has made modest improvements to its surface ship self-defense capabilities since 1996. Its 1998 assessment of self-defense capabilities shows only limited measurable improvement toward defeating the far-term threat (2012 and beyond). Even if all of its planned additional improvements can be realized, the Navy projected that four ship classes will have moderate capability in defeating the far-term threat. We believe that the Navy projections are overstated because (1) the assessment is based on Navy assumptions that are optimistic and (2) the Office of Naval Intelligence now projects that the next generation of anti-ship cruise missile threats will become operational much sooner than the Navy projected at the time of the assessment. Moreover, existing capabilities have been reduced by funding, maintenance, and spare parts problems that are reducing the availability of a number of important self-defense systems.

[5]The Navy defined a contested environment as one in which the degree of violence approaches that of a global war or a major regional conflict, requiring the commitment of a large number of ships that would be placed at risk; an uncertain environment as one involving lesser regional and low intensity conflict in which fewer surface combatants, but a larger number of amphibious ships, would be placed at risk; and a controlled environment as one in which a mix of individual ships would conduct presence operations during peacetime, at a low level of risk.

[6]The PRA model is a method for assessing the defensive capability of each ship class against specific threats. The PRA value is an expression of the degree of probability that no anti-ship cruise missiles in a particular raid will hit a targeted ship. For example, a ship class that can generate a PRA of 0.9 has a 90-percent probability of defeating cruise missiles directed against it.

Some Improvements Have Been Made

The Navy has spent $3.8 billion on ship self-defense efforts since 1996, largely focusing on research and procurement activities related to anti-cruise missile systems such as the Rolling Airframe Missile, the Phalanx Close-in Weapon System, the Rearchitectured North Atlantic Treaty Organization (NATO) Sea Sparrow Surface Missile, the Cooperative Engagement Capability system, the Ship Self Defense System, electronic countermeasure systems, and radar improvements. However, from 1996 through 1998, only one amphibious ship class—the Whidbey Island and Harpers Ferry class of dock landing ships—received equipment that provides measurable improvement against near- and mid-term cruise missiles. This class accounts for only 12 of 150 surface ships having cruise missile self-defense requirements. These 12 ships have received, or are scheduled to receive, an improved version of the SPS-49 radar, the Ship Self Defense control system, the Rolling Airframe Missile system, and the Phalanx Block 1A. The Navy estimates that these improvements, when completed, will more than double the assessed capability of these ships to defeat near- and mid-term threats. However, they will provide only low capability against far-term threats.

Though not reflected in measurable improved self-defense capabilities, the Navy has also installed improved self-defense equipment on some of its other surface ships. For example, it installed (1) the Rolling Airframe Missile on landing helicopter assault and dock ships and on Spruance class destroyers; (2) upgraded versions of the Phalanx Close-in Weapon System on frigates, Aegis[7] destroyers, and landing helicopter dock and dock landing ships; and (3) radar upgrades on carriers, frigates, dock landing ships, and landing helicopter dock ships. A list and description of the Navy's current and planned ship self-defense equipment for surface ships are in appendix II.

Additional Improvements Are Planned

The key to defeating future cruise missile threats is in gaining additional reaction time for defending ships to detect, divert, or engage them. As future missiles will be much faster and have more range, Navy surface ships must be able to detect them sooner. Once the hostile missiles are detected, a ship's combat system must be able to rapidly process

[7]Aegis combat system is an integrated shipboard weapon system that combines computers, radar, and missiles to provide a defense umbrella for surface ships. The system is capable of automatically detecting, tracking, and destroying airborne, seaborne, and land-launched weapons.

information about them and generate recommendations to counter them. Finally, the ship's weapon systems must be able to engage threat missiles quickly and accurately and to overcome the incoming missiles' countermeasures.

The Navy plans to spend about $5.1 billion over the next 6 years to upgrade the detection, control, and engagement components of the self-defense capability of selected ship classes. These plans are summarized in table 2. In responding to the Department of Defense (DOD) technical comments, we have revised table 2 to reflect the Navy's current plans to improve the defensive systems of these ship classes. The revised table 2 reflects Navy plans as of June 2000. The original table 2 reflected Navy's planned improvements as of October 1998. Table 4 contains the projected capability associated with the Navy's planned improvements as of October 1998. The Navy did not provide us with revised projected capability values to associate with its June 2000 plans.

Table 2: Planned Equipment Additions or Improvements, as of June 2000

Ship class	Detection	Control	Engagement
Aircraft carriers	Horizon search radar	Ship Self Defense System and Cooperative Engagement Capability	Upgraded Rolling Airframe Missile, Rearchitectured NATO Sea Sparrow Surface Missile, Evolved Sea Sparrow Missile
Landing helicopter assault ships	MK 23 TAS Upgrade	No plans	Upgraded Rolling Airframe Missile (not funded)
Landing helicopter dock ships	Horizon search radar	Advanced Combat Direction System and Ship Self Defense System	Upgraded Rolling Airframe Missile, Rearchitectured NATO Sea Sparrow Surface Missile
Amphibious transport dock ships	Horizon search radar	Ship Self Defense System	Upgraded Rolling Airframe Missile and NULKA
Dock landing ships	No plans	Ship Self Defense System	Upgraded Rolling Airframe Missile and NULKA
Spruance class destroyers	MK 23 TAS upgrade	No plans	Upgraded Rolling Airframe Missile and NULKA
Aegis destroyers	Enhanced Aegis phased array radar	Enhanced Aegis Combat System	Upgraded Standard Missile, Evolved Sea Sparrow Missile, NULKA, and electronic warfare system
Aegis cruisers	Enhanced Aegis phased array and horizon search radars	Enhanced Aegis Combat System	Upgraded Rolling Airframe Missile, Evolved Sea Sparrow Missile, NULKA, and electronic warfare system
Frigates	No plans	No plans	Phalanx Block 1B (12 CORT ships only)
Fast combat support ships	No plans	No plans	No plans

Source: Navy planning documents and DOD technical comment updates.

Planned research and development funding is largely concentrated on developing Cooperative Engagement Capability integration, a multifunction radar, and a new electronic warfare system. Planned procurement funding is concentrated on the Cooperative Engagement Capability, Ship Self-Defense System MK I, Rolling Airframe Missile, NULKA, Rearchitectured NATO Sea Sparrow Surface Missile, and Evolved Sea Sparrow Missile systems.

The Navy expects these improvements to increase the self-defense capability of most surface ship classes against near- and mid-term threats. However, when it modeled the projected improvements, the Navy concluded that none of the 10 ship classes would gain a high capability to defeat far-term threats.

Current Surface Ship Self-Defense Capabilities

In October 1998, the Navy assessed both the current and projected self-defense capability of the affected nine ship classes, as part of its budget planning for fiscal year 2000. The assessment of current capability concluded that only Landing Helicopter Dock and cruiser class ships would have a moderate to high capability against the near-term threats and no class would have an equivalent capability against the mid- or far-term threats (see table 3). Aegis cruisers and destroyers can be assigned an area air-defense role and are equipped with the most advanced combat system in the world, yet the Aegis destroyers were assessed at having a moderate capability against the near-term threats and a low to moderate capability against the mid-term threats. The ship classes least able to counter near-term threats are aircraft carriers, support ships, and frigates. The risk that these ship classes can be successfully attacked by hostile cruise missiles remains high.

Table 3: Existing Cruise Missile Defense Capability by Ship Class, as of October 1998

Ship class	Level of Capability by Threat Time Period		
	Near-term threat (1998-2005)	Mid-term threat (2006-2011)	Far-term threat (2012 and beyond)
Nuclear carriers	Low	Low	Low
Landing helicopter assault ships	Low to moderate	Low	Low
Landing helicopter dock ships	Moderate to high	Low	Low
Dock landing ships	Moderate	Low	Low
Spruance class destroyers	Moderate	Low	Low
Aegis destroyers	Moderate	Low to moderate	Low
Aegis cruisers	Moderate to high	Moderate	Low
Fast combat support ships	Low	Low	Low
Frigates	Low	Low	Low

Source: GAO analysis of October 1998 Navy assessment.

The assessment of projected capability, summarized in table 4, showed that four classes of Navy surface ships are expected to receive improvements that would provide a moderate defensive capability against the far-term threat missiles and no ship class would have a high capability against this threat.

Table 4: Projected Cruise Missile Defense Capability as of Program Objective Memorandum 2000, as of October 1998

Ship class	Level of Capability by Threat Time Period		
	Near-term threat (1998-2005)	Mid-term threat (2006-2011)	Far-term threat (2012 and beyond)
Nuclear carriers	Moderate to high	Moderate to high	Low to moderate
Landing helicopter assault ships	Low to moderate	Low	Low
Landing helicopter dock ships	High	High	Moderate
Amphibious transport dock ships	High	High	Moderate
Dock landing ships	High	Moderate to high	Low
Spruance class destroyers	Moderate to high	Moderate	N/A
Aegis destroyers	High	High	Moderate
Aegis cruisers	High	High	Moderate
Fast combat support ships	Low	Low	N/A
Frigates	Low	Low	N/A

Source: GAO analysis of October 1998 Navy assessment.

The projected capability improvements shown in table 4 are Navy estimates as of October 1998. They are based on an assumption that all the ships in each class will have been fitted with all of the planned self-defense equipment in time to deal with emerging threats. However, some threat missiles that were projected to become operational in the far-term are emerging more rapidly than previously forecast.

The frigate and fast combat support ship classes have the least self-defense capability. The Navy plans to upgrade the self-defense capability of the 12 CORT Oliver Hazard Perry class frigates by installing the Phalanx Block 1B. However, the Navy is not planning to upgrade the defense capability of fast combat support class ships because it has been considering the possibility of transferring these ships to the Military Sealift Command since at least 1997.

Ship Self-Defense Capabilities Based on Optimistic Assumptions

Optimistic assumptions used by the Navy in its assessment models have led it to overstate existing and projected ship self-defense capabilities. The models used in the assessment to determine capabilities include a number of optimistic assumptions that may not reflect the reality of normal fleet operations. Among these assumptions are perfect weather, uninterrupted equipment availability, and perfect crew and equipment performance at all times. In commenting on our report, the Navy added that the optimistic assumptions have repeatedly resulted in understated requirements for multispectral detection capability in littoral regions and the need for infrared sensors to provide anti-ship cruise missile detection when radar performance is degraded by natural or man-made conditions. Further, the models assumed that all the ships of an assessed class have the planned improvements already installed. We collected information on the equipment actually installed on each ship in the affected classes as of September 30, 1999. This information showed that not all of the 12 ships in the two Dock landing ship classes had received the equipment on which the Navy's assessment is based. For example, only 7 of the 12 ships had received the improved Ship Self-Defense System MK-1 system. Further, the Navy's assessment of the self-defense capability of Spruance class destroyers is based on the inclusion of the Rolling Airframe Missile (RAM) Block 0 in the equipment suite. However, we found that only 6 of the 24 ships in this class had actually received this missile system.

Inadequate Funding, Maintenance, and Parts Support Reduce Equipment Availability

Some of the existing ship self-defense systems have not met the Navy's own standards for availability because the Navy has not adequately funded needed overhaul, spare parts, and technological upgrades. For example, while the fleet availability standard for equipment is 80 percent, the availability rate for some versions of the SLQ-32 electronic warfare system has been as low as 35 percent. According to Navy officials, the low availability rate resulted because the Navy funded the development of a replacement system instead of funding needed spare parts and available upgrades.

According to the Navy's Material Readiness Database for fiscal years 1997 through 1999, the SLQ-32 electronic warfare system, NATO Sea Sparrow Surface Missile System (NSSMS), Phalanx Close-in Weapon System, and the SPS-48E radar system were among the ship self-defense systems with the lowest availability rates. Table 5 presents data on the average availability of these systems and impediments to their availability.

Table 5: Availability Rates of Selected Ship Self-Defense Equipment

Equipment type and version	Availability rate[a]			Impediments to availability
	FY 97	FY 98	FY 99	
SLQ-32 Electronic Warfare System				
V2	0.72	0.70	0.69	High cost of parts, lack of funding for parts and upgrades, parts failure, lack of technician experience, and training.
V3	0.76	0.55	0.45	
V5	0.41	0.53	0.35	
NSSMS				
Mark 57 Bl 1R/mods2/3	0.79	0.84	0.78	Failure and high cost of components, excessive parts usage, nonavailability of parts onboard, excessive operational tempo, and maintenance requirements.
Phalanx Close-in Weapon System				
Block 0	0.71	0.82	0.68	Lack of funds for timely overhaul, hydraulic problems, limited parts commonality, excessive parts usage, lack of onboard spare parts, lack of onboard repair and preventive maintenance, crew inexperience, and inadequate manning for maintenance.
Block 1 Bl0	0.80	0.78	0.81	
Block 1 Bl1/2/1A	0.72	0.77	0.73	
SPS-48E Radar System				
	0.73	0.81	0.77	Inadequate training of shipboard technicians, lack of technical schematics, and no parts support for sub-modules.

[a]Rates reported in the 1999 CINCPACFLT/CINCLANTFLT Combat Systems Troubled Systems Process Report before remedial action was taken. The Navy's measure of effectiveness for Equipment Operational Capability (availability) is classified in the following manner: Operable = Greater than 0.8; Minor problems = 0.7 - 0.8; Limited capability = 0.5 - 0.6; Major problems = 0.3 - 0.4; Inoperative = 0 - 0.2.

Source: Navy Material Readiness Database.

Atlantic and Pacific Fleet commanders and maintenance officials we interviewed said that the Navy is not placing adequate emphasis and funding priority on the maintenance of existing systems because it would rather focus on developing new systems. However, the present systems will remain in the fleet for a number of years before replacement systems are fielded. For example, the Navy will continue to have versions of the SLQ-32 on some of its ships for at least another 10-20 years. However, the 30-year-old technology of the SLQ-32 cannot be upgraded or modified to provide the full capability needed by the fleet to deal with the modern missile threat. A similar situation exists with the NSSMS. The NSSMS on nuclear carriers and landing helicopter dock ships are slated for upgrade to a very high availability, local area network integrated configuration, the Rearchitectured NATO Sea Sparrow Surface Missile System. This program has been extended beyond the initial requirement time frame, resulting in continued low availability rates for the NSSMS remaining on ships in the fleet for another 7-10 years.

Since 1996, the Navy increased annual ship self-defense related operations and maintenance funding from about $75 million to about $112 million in fiscal year 2000. Moreover, almost $128 million is projected for fiscal year 2005. Officials responsible for maintenance and overhaul said that additional resources would be needed to improve availability of systems. However, according to these officials, even if the Navy provided additional resources, improvement would take many years because ships are frequently not available for installation of upgrades due to operational commitments. In commenting on our report, the Navy also noted the importance of recognizing the impact on funding from extended maintenance of both legacy and upgraded systems due to protracted procurement and installation plans.

Self-Defense Efforts Lack Comprehensive Plans and Face Declining Budgets

The Navy lacks a comprehensive strategy for acquiring and installing self-defense systems on its surface ships. Plans for developing and fielding improved self-defense equipment are incomplete and inconsistent, do not measure progress against a baseline, and do not provide clear timelines for the achievement of needed capabilities. Navy leaders express concern about the vulnerability of surface ships and say they are placing a priority on improving surface ship self-defense capabilities, but they have not directed any significant funding increases to these efforts. Research and development spending related to ship self-defense has declined about 9.4 percent over the last 5 years and is projected to decline more than 44 percent over the next 6 years. This trend may limit Navy efforts to develop technological solutions needed to defeat projected future threats.

Navy Lacks Comprehensive Strategy

The Navy lacks a comprehensive strategy for improving its surface ship self-defense capabilities. Plans presented in the reports it has prepared since 1996 are incomplete because they (1) do not cover all affected ship classes, (2) do not consistently contain stated priorities, (3) do not consistently reference a baseline from which to measure progress, and (4) do not address time frames for achieving required capabilities. Instead, these reports largely detail the status of individual systems.

For the period 1996-99, we examined a series of congressionally mandated Navy reports on ship self-defense plans, objectives, schedules, and funding requirements[8] as well as several internal Navy documents dealing with investment alternatives. We found that the Navy's plans did not cover all affected ship classes and lacked consistent improvement priorities. For example, the ship classes covered by these reports varied from one year to another and excluded coverage of ship self-defense for Aegis destroyers and cruisers in all but its most recent investment briefing. Our analysis also showed that the Navy did not consistently articulate its priorities for improving self-defense capabilities among the affected ship classes. The Navy's 1997 report to Congress described improving carriers and some amphibious ship classes (landing helicopter dock ships, and dock landing ships) as a priority, but it offered no rationale for selecting these classes. Subsequent reports focused on these same ship classes and added the planned amphibious transport dock ship class, but they did not prioritize improvements for the remaining six ship classes.

We also found that established baselines for measuring progress on ship self-defense have not been used on a consistent basis. Navy reports to Congress in 1996 and 1997 contained ship class baselines[9] that spelled out the planned self-defense equipment configuration by the various ship classes. Later reports and briefings made no mention of progress toward meeting these baselines. Instead, the reports and briefings measured current equipment configurations against short-term program goals rather than baselines. Further evidence of the use of fluctuating short-term program goals arose when we reviewed the Navy's installation plans for the horizon search radar (the SPQ-9B) as depicted in its budget justification documents for fiscal years 1997-2001. These documents reflected three changes in 5 years as to which ship classes and how many ships within each class would received this radar. In addition, installation plans for this system had been continually stretched out. While some degree of change in program plans and budgets is to be expected over time, Navy ship self-defense program plans seem to be in a fluid state from one year to the next.

[8]House Committee on Armed Services report on the National Defense Authorization Act for Fiscal Year 1995 (H.R. Rep.103-499 at 106-107) required the Navy to submit annual updates up through fiscal year 1999 on program objectives, plans, schedules, and funding requirements for anti-air warfare programs.

[9]National Defense Authorization Act for Fiscal Year 1996 Conference report (H.R. Rep. 104-450 at 668) required the Navy to include an assessment of progress in establishing and meeting baselines in the above mentioned annual updates.

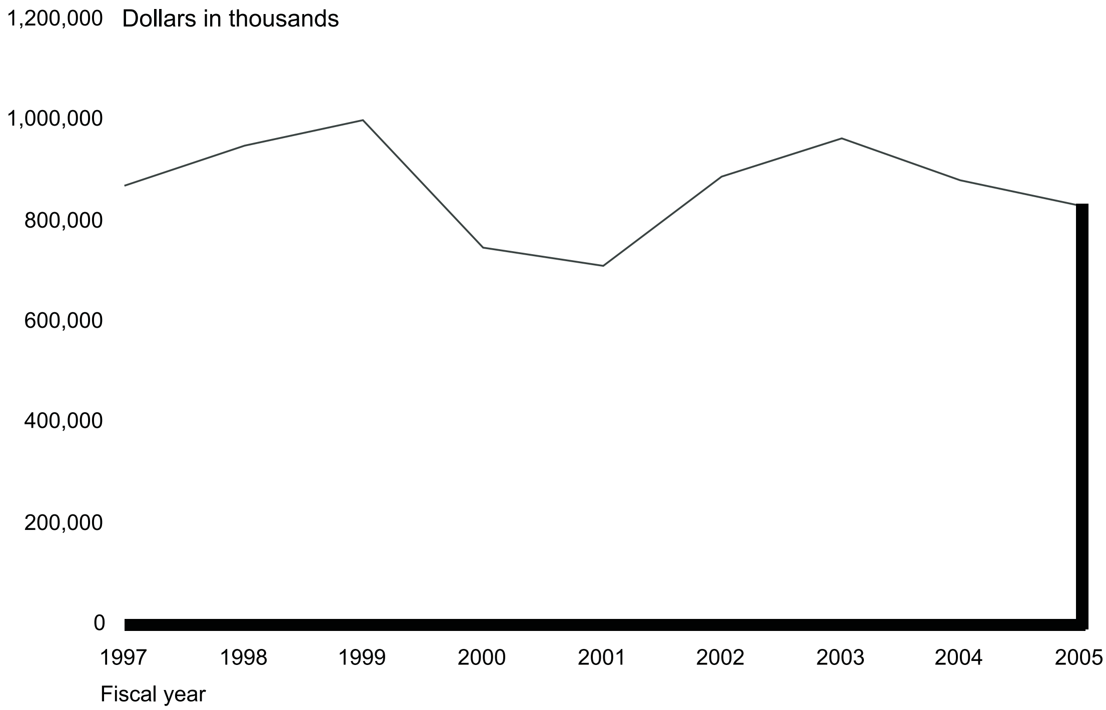
Using a succession of short-term goals as the reference point for measuring progress instead of using a stable baseline makes it difficult to determine how much progress the Navy is making toward meeting the Self-Defense Capstone Requirements.

Finally, only the 1997 report to Congress provided a timeline for achieving the self-defense requirements by ship class. This timeline is neither repeated nor expanded upon in subsequent reports or investment briefings. Without a timeline by ship class, it is not possible to know if the Navy will be able to achieve planned improvements in time to defeat evolving cruise missile threats.

Ship Self-Defense Funding

Although the Navy says it places a high priority on improving ship self-defense, it has not dedicated any significant funding increases to these efforts. From fiscal years 1997 to 2005, projected annual spending for ship self-defense programs will fluctuate between $719 million and $1 billion (see fig. 3), and research and development funding is projected to decline from about $517 million to about $218 million (see fig. 4). If the decline in ship self-defense related research and development resources continues, the Navy may not be able to develop the technological solutions it needs to defeat projected threats. Navy officials acknowledged that technologies that are required to defeat far-term cruise missile threats have yet to be developed. In commenting on our report, DOD noted that a comprehensive strategy that communicates priorities and defines required resources would serve as a useful tool for better aligning available resources.

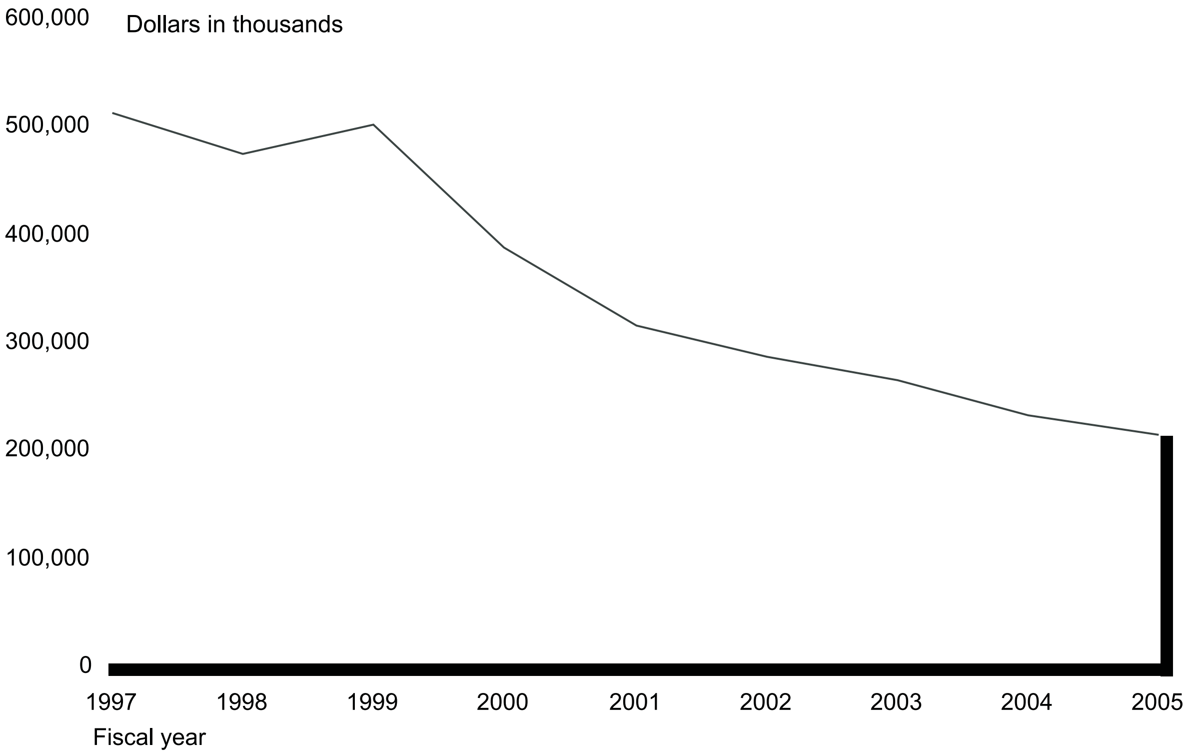
Figure 3: Total Ship Self-Defense Funding



Note: Funding does not include costs of ship construction.

Source: Fiscal year 1999 and 2000 President's budgets.

Figure 4: Ship Self-Defense Research, Development, Test, and Evaluation Funding



Note: Includes science and technology funding for ship self-defense related projects identified by the Office of Naval Research staff.

Source: Fiscal year 1999 and 2000 President's budgets.

Conclusion

Unless the Navy can improve the self-defense capabilities of its surface ships, these ships will be increasingly vulnerable to cruise missile threats when they operate in coastal waters. The Navy lacks a comprehensive strategy for improving their self-defense capabilities, making it difficult to measure progress and to predict future capabilities. Program planning documents and reports prepared by the Navy since 1996 have not covered all affected ship classes, consistently addressed stated priorities, consistently employed baselines to measure progress, or addressed time frames for achieving required capabilities. Instead, they have only provided a status of individual systems. A comprehensive approach would articulate the Navy's ship self-defense improvement plans for the various systems and their application to all the affected ship classes in terms of baselines, with associated funding and timelines for meeting the required capability levels.

In its 1996 report to Congress, the Navy recognized the importance of stability and a long-term view. “A fundamental requirement for the success of these current and future initiatives, however, is adequate and stable funding and long-term commitment for the future.” Without such a comprehensive approach, the Navy’s effectiveness in improving ship self-defense capability may suffer because (1) needed improvements may not be properly defined and prioritized, (2) needed resources to develop and sustain improved capabilities may not be properly identified and applied, and (3) the achievement of required improvement will continue to be difficult to measure.

Recommendation

To provide a complete framework the Navy can use to identify and prioritize needed improvements to ship self-defense capabilities and to provide a baseline to measure and track its progress toward achieving these goals, we recommend that the Secretary of Defense direct the Secretary of the Navy to develop a comprehensive strategy that clearly articulates priorities, establishes baselines, provides timelines, and defines resource requirements for achieving required capabilities.

Agency Comments

In written comments on this report, DOD agreed with our recommendation that the Navy needs to develop a comprehensive strategy for improving ship self-defense capabilities, and it stated that it would request the Secretary of the Navy to prepare such a plan. DOD indicated that it would also request the Secretary of the Navy to re-evaluate whether assumptions used in performance assessment models reflect the reality of fleet operations. The Navy has formed a new modeling and simulation test group with the charter of introducing variables to make the performance assessments more realistic.

We incorporated in this report a number of technical comments provided by DOD. Table 2 originally reflected Navy plans as of 1998. We revised this table to include current Navy plans for improving the ship self-defense capabilities of various ship classes. As the Navy did not provide us with revised projected capability values for its current plans, we were not able to reflect the impact of these plans in table 4.

DOD’s written comments are reprinted in appendix IV.

Scope and Methodology

To determine requirements, plans, and cost of self-defense improvement efforts for the Navy's surface ship, we interviewed officials and obtained documentation from the Office of the Secretary of Defense, the Secretary of the Navy, the Chief of Naval Operations, the Office of Naval Research, and the Commanders in Chief of the U.S. Atlantic and Pacific Fleets. As part of our discussions, we asked officials of the Offices of the Chief of Naval Operations and Naval Research to identify ship self-defense related programs. We received briefings on and reviewed Navy self-defense planning and investment strategy documents. We then determined the Navy's funding projections applicable to those programs over the fiscal year 1995 to 2005 period as contained in the fiscal year 1997 through 2000 President's budgets. We excluded the Navy's Standard Missile program from our funding analysis, because we were unable to determine which parts are chargeable to ship self-defense functions.

To gain an understanding of how the Navy conducted its assessments of ship self-defense capabilities, we reviewed modeling and simulation data prepared by officials from Naval Surface Warfare Center, Dahlgren Division, and discussed the data with officials of the Johns Hopkins University. We also received cruise missile threat briefings from officials from the Office of Naval Intelligence, the Defense Intelligence Agency, and the Central Intelligence Agency.

To assess the Navy's current ship self-defense capabilities, we visited the U.S.S. *Comstock*, U.S.S. *Fitzgerald*, U.S.S. *Hue City*, U.S.S. *George Washington*, U.S.S. *Harpers Ferry*, U.S.S. *Kaufmann*, U.S.S. *San Jacinto,* and U.S.S. *Wasp*. We examined their self-defense systems and interviewed crewmembers responsible for operating and maintaining them.

To assess the availability of the Navy's existing self-defense systems, we interviewed commanders, crewmembers, and other officials, and obtained historical information from the Naval Warfare Assessment Station, Corona, California. We reviewed equipment installation data maintained in a Navy database and verified our analysis with Navy officials.

To assess the Navy's plans and progress in developing improved capabilities, we interviewed officials from the Deputy Assistant Secretary of the Navy for Theater Combat Systems, the Program Executive Offices for Theater Surface Warfare and Expeditionary Warfare, and the Naval Sea Systems Command and its surface warfare centers at Dahlgren, Virginia; Crane, Indiana; and Port Hueneme, California. In addition, we visited a detachment of the Port Hueneme facility located in Louisville, Kentucky. We also obtained information on selected programs from officials from the Naval Air Systems Command.

We conducted our review from July 1999 through May 2000 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Honorable William S. Cohen, Secretary of Defense; the Honorable Richard Danzig, Secretary of the Navy; General James L. Jones, Commandant of the Marine Corps; the Honorable Jacob J. Lew, Director, Office of Management and Budget; and other interested congressional committees. Copies will be made available to others upon request.

Please contact me at (202) 512-4841 or Mr. Richard Price at (202) 512-3630 if you or your staff have any questions concerning this report. Key contributors to this report were Anton Blieberger, Martha Dey, and John Heere.

James F. Wiggins
Associate Director
Defense Acquisitions Issues

Planned Self-Defense Capabilities for Amphibious Transport Dock Ships

This appendix contains the information you requested on the status of planned ship self-defense capabilities of the next generation of amphibious transport dock ships (the LPD-17 class) currently in development. The Navy plans to procure 12 of these ships between fiscal years 2003 and 2009 to replace a larger number of existing amphibious transport ships that are nearing the end of their useful life. The LPD-17 program is currently in the engineering and manufacturing development phase.

In June 1996, the Navy received Milestone II approval for the baseline design of the LPD-17 ship class. The design included a self-defense suite consisting of a SPS-48E radar, a SPQ-9B radar, a SLQ-32(V2) electronic warfare system or its successor, a Ship Self Defense System MK-2, a Cooperative Engagement Capability node for sensor fusion, two Rolling Airframe Missile launchers, an Evolved Sea Sparrow Missile (ESSM) vertical launcher and associated target illuminators, and a decoy launcher. At that time, the Navy realized that the ESSM program schedule would not mesh with the production schedule of the first two ships in the class and decided to reserve space and weight in the ship design for the missile system and launcher. However, the Navy still planned to build the remaining 10 ships in the class with the ESSM and its launcher.

During internal deliberations on the Navy's fiscal year 1999 budget, the Navy decided to remove projected funding for the ESSM and its launcher from the LPD-17 budget in order to fund the cruiser conversion program and other shipbuilding and conversion efforts. However, the Navy directed Avondale Industries to reserve space and weight for the ESSM in the design of all 12 LPD-17 class ships.

In 1998, various congressional committees directed the Navy to prepare an analysis of alternatives to the LPD-17 baseline design, including an evaluation of the AN/SPY-1 radar and its associated Aegis combat system, multifunction radar, and the ESSM. The March 1999 results of the Navy analysis confirmed that the baseline design without the ESSM could meet the near- and mid-term threat at the least cost. As a result of this assessment, the Navy does not plan to equip the LPD-17 class ships with the ESSM. However, if the threat materializes as currently predicted, the Navy could later add improved variants of the ESSM and the Rolling Airframe Missile as weapon modifications on these ships. These improved variants are yet to be developed. In addition, if the threat warrants it, the Navy could also back-fit multifunction and volume search radar on the LPD-17, when they become available.

Current and Planned Ship Self-Defense Equipment

Detection Elements

AN/SPS-48 Air Search Radar: The AN/SPS-48 is a medium-range, three-dimensional (height, range, and bearing) air search radar whose primary function is to provide target position data to a weapon system and a ship command and control system. It provides for detection of targets as high as 100,000 feet and over a distance of 2 to 200 miles. At the present time, only the AN/SPS-48E version can be found in the fleet. Specifically, the 48E version is installed in the following ship classes: CV/CVN, LHA, and LHD. Also, the Navy plans to install the 48E version in the LPD-17 ship class.

AN/SPS-49 Air Search Radar: The AN/SPS-49 radar is a long-range, two-dimensional (range, bearing) air search radar whose primary function is to provide target position data to a ship command and control system. It provides for detection of targets as high as 100,000 feet and over a distance of 2 to 300 miles. The current version, AN/SPS-49V, is installed in the following ship classes: CV/CVN,CG-47, FFG-7, LSD 41/49, and LHD.

AN/SPS-49 Medium Pulse Repetition Frequency Upgrade (MPU): The MPU incorporates key ship defense enhancements to the Navy's AN/SPS-49 air search radar. Specifically, it provides for increased detection of low-observable targets, reduces reaction time through internal firm track criteria changes, and enhances performance against electronic countermeasures and naturally occurring clutter. The AN/SPS-49 MPU is or is planned to be installed on the following ship classes: CV/CVN, FFG-7, LSD 41/49, and LHD.

AN/SPQ-9A Low-Search Radar: The AN/SPQ-9A radar provides for detection of surface targets. It is currently installed on CG 47 class cruisers and DD 963 class destroyers. The AN/SPQ-9A radar interfaces with the MK-86 Gun Fire Control System on DD-963 class ships.

AN/SPQ-9B Upgrade Horizon Search Radar: The AN/SPQ-9B represents a product improvement to the AN/SPQ-9A radar that will enhance its ability to detect and track high-speed, low-radar cross section sea-skimming targets in high-clutter coastal environments. The AN/SPQ-9B uses a high resolution, track-while-scan, pulse-Doppler radar to provide rapid acquisition and automatic tracking of multiple targets. The AN/SPQ-9B is to be interfaced with either the MK-86 Gun Fire Control System, the Ship Self Defense System, or the Aegis Combat Direction System.

In October 1994, the Navy awarded an engineering and manufacturing development contract for two AN/SPQ-9B prototypes—one to be used as a contractor test set and one to support land-based testing at Port Hueneme, California. Following land-based tests, the Navy exercised three options to produce six low-rate initial production units to meet ship delivery schedules and to support developmental and operational testing aboard the U.S.S. *Oldendorf* (DD 972). Although early development tests were successful, a change in program policy called for the AN/SPQ-9B radar to be installed on ship classes that could not carry the weight of the development (heavyweight) antenna. As a result, the Navy developed a prototype lightweight antenna assembly. The prototype is currently being maintained by the contractor for use as a test set. A modification to the existing contract enabled the Navy to procure two lightweight antenna radar sets, as well as three lightweight antenna backfit sets.

During November 1999 shipboard developmental testing with a heavyweight antenna, the Navy encountered an unexpected interference problem with the AN/SLQ-32 electronic warfare system. According to Navy officials, the problem is of an electromagnetic nature and would have occurred even if a lightweight antenna had been used. The problem is currently being investigated and will likely delay the system's operational evaluation. According to Navy officials, the delay of the operational evaluation will not impact the planned procurement contract for three SCN radar sets in fiscal year 2000.

The Navy plans to install the lightweight AN/SPQ-9B radar on LPD 17, CVN, and LHD ship classes and on selected CG ships through fiscal year 2007.

AN/SLQ-32 Electronic Warfare System: The AN/SLQ-32 is a family of electronic warfare systems comprising five modular variants with varying levels of capability. The SLQ-32A(V)1 provides for early warning, identification, and direction-finding of incoming radar-guided anti-ship cruise missiles. The A(V)2 variant provides early warning, increased frequency range, identification, and direction-finding of missile targeting radars, and the A(V)3 variant adds a jamming capability. The A(V)4 is a modified (V)3 variant specifically for aircraft carrier installation. The (V)5 variant is a modified (V)2 for FFG-7 class ships, which adds jamming capability. One or more versions of the AN/SLQ-32 electronic warfare system are installed in each ship class discussed in this report.

Advanced Integrated Electronic Warfare System (AIEWS): AIEWS is currently under development as the next generation shipboard electronic warfare system. Increment I of the two-increment program is to include an advanced display, improved emitter processing, enhanced combat system integration, and a new receiver package. Increment II is to include an advanced electronic attack subsystem and advanced off-board countermeasures. AIEWS is being designed for employment of layered countermeasures in the coastal operating environment, with specific emphasis on the full integration of all soft kill elements into the ship's control system.

Infrared Search and Track (IRST): Currently in development, IRST is a shipboard, lightweight, passive infrared sensor that scans the horizon to automatically detect and declare both subsonic and supersonic threat missiles that fly at low altitudes. In April 1999, the IRST prototype successfully detected and tracked Exocet missiles while installed on the U.S.S. *O'Bannon* (DD 987). In August 1999, the IRST contractor successfully linked the only existing IRST prototype scanner to two separate computer interfaces—CEC baseline 1 and Aegis. In June 1999, the Navy exercised a contract option to upgrade the prototype's signal processing and control unit to provide for enhanced reliability and incorporate other minor improvements into the only prototype unit. The upgraded unit is to be delivered on May 21, 2002. Though Navy officials would like to have acquired additional IRST prototype units for further risk reduction efforts and to participate in a joint U.S./foreign navy exercise in fiscal year 2001, there are no funds in the Future Years Defense Program to do so.

Thermal Imaging Sensor System (TISS): TISS, a stand-alone shipboard sensor used primarily for situational awareness, was designed to detect floating mines, small surface craft, and low flying aircraft. It consists of a thermal imaging (infrared) sensor, two television cameras, and a laser range finder. Though not developed to detect incoming cruise missiles, TISS has a limited ship self-defense application. Specifically, its sensors can be used to monitor land-based cruise missile launching sites in places such as the Straits of Hormutz and the Persian Gulf, if a line of sight to the launch site is available.

In October 1995, the Navy awarded an engineering and manufacturing development contract for a single engineering test unit. The test unit was successfully tested aboard the Self Defense Test Ship in May 1996. In April 1997, the Navy awarded a production contract for 24 units. In April 1999, during development of the Navy's fiscal year 2000 budget submission, the Navy reprogrammed nearly all outyear TISS procurement funding

($50.2 million) to higher priority programs. As of March 2000, the Navy had installed 6 of 11 delivered production units on selected frigates and amphibious class ships most likely to be deployed to the Persian Gulf. Due to quality control problems at sub-vendor facilities, delivery of the remaining 13 production units has been delayed until October 2000.

AN/SPY-1A, 1B, and 1D Radars: The SPY radar is the multi-function, phased-array radar that conducts search, automatic detection, and tracking of air and surface targets aboard Aegis cruisers and destroyers. The SPY-1A, installed on CG-47 through CG-58, uses a digital signal processor and a four-bay AN/UYK-7 control computer. The SPY-1B radar, installed in CG-59 through CG-73 cruisers, also uses a digital signal processor and either a four-bay AN/UYK-7 or upgraded AN/UYK-43 control computer. The SPY-1D, installed on DDG-51 through DDG-78, is a variant of the SPY-1B radar. The SPY-1D provides better performance against targets than the earlier SPY versions.

Multi-function Radar (MFR): In June 1999, the Navy awarded a contract to develop an MFR prototype. The Navy expects the radar to perform such functions as horizon search, limited above-the-horizon search, and fire control track and illumination. One of the most significant design features of the radar is to provide automatic detection, tracking, and illumination of low-altitude threat missiles in adverse environmental conditions routinely found in coastal waters. Based on current program plans, the initial MFR prototype will be available in fiscal year 2002 to support land-based and sea-based testing.

The Navy intends for the MFR to replace legacy radars currently found on CVN 68 class carriers including the SPS-67, Mk 23 TAS with Mk 95 illuminator or SPQ-9B, and the SPN-41/46 radars, which provide glide slope for approach control on aircraft carriers. Current Navy plans call for inclusion of the MFR on CVN 77, which is expected to enter service in December 2007, and the DD 21 ship class. Other installation candidates are LHD 8, CVN 70–76 (as a backfit), and CVN(X) and LH(X) future ship classes.

Additionally, the Navy will review the LPD 17 combat system in 2001 to determine if changes in configuration are warranted. The costs and benefits of including the MFR/VSR suite in the LPD 17 combat system suite will be considered in this review.

Volume Search Radar (VSR): According to requirements for the DD 21 ship class, the Navy intends to have an integrated radar suite that will comprise both the multi-function radar and VSR. The Navy expects the VSR to perform long-range detection and tracking of airborne traffic above-the-horizon and high flying cruise missile threats as well as to provide cueing data to the multifunction radar. During deliberation of the Navy's fiscal year 2000 budget request, Congress provided the Navy with a $12-million plus-up to begin VSR development. Based on current program plans, the initial VSR prototype will be available during fiscal year 2002 to coincide with MFR development testing.

Both DD 21 Industry Teams will develop a VSR capability in the context of the design competition for that ship class. It is the Navy's intent that the MFR/VSR radar suite will be the radar suite for the CVN 77, and will replace the SPS-48E, SPS-49, and SPN-43 (air traffic control) radars currently on CVN-68 class ships. VSR is also a candidate for installation in LHD 8, CVN 70–76 (as a backfit), CVN(X), and LH(X).

Additionally, the Navy will review the LPD 17 combat system in 2001 to determine if changes in configuration are warranted. The costs and benefits of including the MFR/VSR suite in the LPD 17 combat system suite will be considered in this review.

Cooperative Engagement Capability (CEC): The objective of the CEC program is to develop a means of integrating all of the radar detection sensors of a battle force's ships and aircraft and for transmitting the resulting common composite radar track data directly into the combat systems of the ships on the CEC network. Currently, no two ships within a battle force can currently "see" the same radar picture. Consequently, the engagement capability of each ship is limited, in part, by the quality of the data its own radar sensors are able to provide to its combat system. If the CEC network can be made to work as envisioned, individual ships would be able see and use composite radar tracks developed by all of the ships of a battle force and some aircraft in a single-integrated-air picture. The composite track data could be frequently updated and fed directly into the combat system of each ship of the battle force. This composite track data would be of "fire-control" quality, and would allow all of the battle force's ships to engage targets without any additional processing or human intervention.

The Navy fielded the first CEC system in 1998. The Department of Defense supported the Navy's fiscal year 2001 budget submission to procure a total of 220 CEC systems by the end of fiscal year 2012. Seventy-nine of these systems are to be integrated with the Aegis combat systems of cruisers and destroyers. The remaining CEC systems will be placed on other ships and aircraft, but will not necessarily be integrated with their combat systems. In response to congressional direction, efforts are also underway to fully integrate CEC into some Navy E-2C aircraft, an Air Force E-3 aircraft, and the Army Patriot Air Defense Guided Missile System.

Because of a lack of progress in integrating CEC on Aegis ships, in the Fiscal Year 1999 Defense Authorization Conference Report 105-736, Congress directed the Navy to report at least quarterly to the Congressional Defense Committees on Cooperative Engagement Capability/combat direction system interoperability problems and planned solutions. The Navy has provided six such reports through March 2000.

The Navy has made some progress toward demonstrating a CEC capability on two Aegis cruisers in the spring of fiscal year 2001. Many of the problems standing in the way of Aegis and CEC interoperability have been identified and are being fixed. However, a single-integrated-air-picture display capability on a single console is not expected to be available until the Aegis weapons system baseline 6 Phase 3 computer programs become available, after the scheduled follow-on test and evaluation in fiscal year 2002.

Control Elements

Aegis Combat System: The Aegis combat system was designed as a total weapon system, from detection to kill. The heart of the system is the advanced, automatic detect and track, multi-function phased-array radar, the AN/SPY-1. It can detect and track hundreds of targets at ranges in the hundreds of miles. The core of the Aegis combat system is its computer-based command and decision element. This interface makes the Aegis combat system capable of simultaneous operation against a multi-mission threat, anti-air, anti-surface, and anti-submarine. The Aegis combat system is or will be installed on all CG-47 cruisers and all DDG-51 destroyers.

Rapid Anti-Ship Cruise Missile Integrated Defense System (RAIDS): RAIDS is a tactical decision aid for a ship’s Commanding Officer/Tactical Action Officer providing automatic display of anti-ship cruise missile threats, depicting active and passive sensor display and showing status of existing ship engagement systems. A multiple microprocessor-based system, RAIDS considers threat capabilities, environmental data, ship-unique characteristics, and approved tactical doctrine in determining appropriate recommendations. RAIDS was developed as an interim system in the approved incremental acquisition of the SSDS MK I system. RAIDS is installed on 12 Oliver Hazard Perry class frigates and 24 Spruance class destroyers.

Advanced Combat Direction System (ACDS): ACDS is a centralized, automated command and control system for aircraft carriers and amphibious warfare ships that communicates engagement and other orders to combat system components and units throughout a battle group. The program has been divided into Block 0, an initial system, and Block 1, the follow-on system. Currently, ACDS Block 0 is installed on nine aircraft carriers and eight amphibious ships.

ACDS Block I focused on developing a new advanced tactical computer program with significant improvements in tactical data link interoperability, automated engagement doctrine, increased range and track capacity, and other improvements. In February 1998, the Commander, Operational Test and Evaluation Force, determined that ACDS Block I was not operationally suitable or effective for deployment. As a result, the Navy decided to (1) make minimal enhancements to the ACDS Block 1 software and (2) limit installation to five ships (three aircraft carriers and two amphibious ships). The functionality of the ACDS Block I command and control system will be integrated into the Navy's Ship Self Defense System MK II development effort.

Ship Self Defense System (SSDS) MK I: SSDS MK I consists of a computer network, special software, microprocessors, and operator displays and workstations. The SSDS MK I is designed to integrate both individual sensors and weapon systems and automate the tracking, assessment, prioritization, and engagement of threat anti-ship cruise missiles to enhance ship survivability.

The SSDS MK I completed development testing in May 1997 and operational testing in June 1997 onboard U.S.S. *Ashland* (LSD 48). During operational testing, every one of more than 200 targets presented to the ship were detected and tracked by the system. In September 1997, the Commander, Operational Test and Evaluation Force, declared the system to be operationally effective and suitable, and he recommended fleet introduction. As a result, the Assistant Secretary of the Navy for Research, Development and Acquisition approved the SSDS program for full-rate production in March 1998. To date, SSDS MK I installations have been completed on five LSD 41 and two LSD 49 class ships. The Navy plans to complete installation of the SSDS MK I on the remaining LSD 41/49 class ships by December 2001.

SSDS MK II: SSDS MK II is the evolutionary development of the SSDS MK I expanded to include the integration of sensors and weapons. SSDS MK II is planned for installation on CV/CVN, LHD, and LPD 17 ship classes.

The Navy issued a letter contract for three SSDS MK II hardware sets in December 1998 and awarded a software development contract in April 1999. Developmental testing is currently scheduled to begin in March 2002.

Common Command and Decision (CC&D) Program: CC&D represents the Navy's future ship self-defense control solution. CC&D is a preplanned product improvement to the Aegis weapon system and the Ship Self Defense System MK II that would replace the major command and decision capability in these systems with a common computer architecture. The Navy is funded for an initial delivery around 2010, but has identified fiscal years 2006-08 as the optimal delivery time frame.

Engagement Elements

Standard Missile (SM): The SM is a ship-launched, medium- to long-range missile system family that provides advanced air defense for an entire fleet area. The first generation, SM-1, is essentially a home-all-the-way missile in medium- and extended-range versions. Oliver Hazard Perry-class frigates use the SM-1 missile both in area defense roles and to defend themselves against incoming cruise missiles.

The latest generation of the SM is the SM-2. The SM-2's primary role is to provide area defense against enemy aircraft and anti-ship cruise missiles. The SM-2 capitalizes on communication techniques, advanced signal processing and propulsion improvements to substantially increase intercept range, high- and low-altitude intercept capability, and performance against advanced threats. The SM-2 Block IIIB is the latest version to enter the fleet, and incorporates a side-mounted infrared seeker for terminal guidance against a known fielded threat. The SM-2 Block IV is the latest version to enter production and deployment, and it provides an extended-range capability with the addition of a MK 72 booster. Aegis cruisers and destroyers use these and other SM-2 versions in area defense roles as well as to defend themselves against incoming cruise missiles.

The SM-2 Block IVA, currently under development, will utilize a side-mounted imaging infrared seeker to detect and track incoming ballistic missiles and guide to a lethal intercept, while retaining previous SM-2 Block IV capabilities. In January 1997, a prototype test vehicle successfully intercepted a representative Theater Ballistic Missile target. In September 1997, the Navy awarded an Engineering and Manufacturing Development contract to build 46 test vehicles required for developmental and operational testing. During fiscal year 1999, however, the program began encountering problems that directly impacted the start of the flight-test program. The problems included vibration-induced test failures, less than anticipated software code reuse, technical challenges associated with design and integration of multiple sensors, and various schedule and cost impacts related to contractor business consolidation decisions. Collectively, the problems resulted in a 6-month delay of the first control test vehicle flight and program cost growth of $55 million. According to program officials, the problems have been addressed and a fix for the vibration anomaly has been incorporated into the missile design. The first control test vehicle flight was successfully completed in June 2000.

NATO Sea Sparrow Surface Missile System (NSSMS): NSSMS is a medium-range missile weapon system that provides the capability of destroying hostile aircraft, anti-ship missiles, and airborne and surface missile platforms. Thirteen nations fund the NSSMS program cooperatively and utilize the system in various configurations aboard many ships. The U.S. NSSMS consists of a MK 91 Guided Missile Fire Control System (GMFCS) and a MK 29 Guided Missile Launching System (GMLS). The GMFCS is a computer-operated fire control system that provides automatic acquisition and tracking of a designated target, generates launcher and missile orders, and in the automatic mode initiates the firing command when the target becomes engageable. The GMLS is a lightweight launching system that provides on-mount stowage and launch capability of up to eight missiles. The NSSMS employs RIM-7 surface-to-air/surface-to-surface semi-active homing missiles. The missile utilizes the energy reflected from the target and from radio frequencies transmitted from its director system for developing missile wing movement orders enabling target intercept. NSSMS is currently installed on DD 963, LHD, AOE, and CV/CVN class ships.

Rearchitectured NATO Sea Sparrow Surface Missile System (RNSSMS): In July 1995, the Navy awarded a contract to develop the necessary software and hardware for a RNSSMS. When fully developed and tested, the RNSSMS will replace the legacy NSSMS closed architecture design and unique display consoles with an open, distributed processing architecture and Navy standard display consoles. Specific features of the new design include, but are not limited to, cross utilization of launchers and directors, reduced manning requirements, and interoperability with SSDS MK II. Collectively, these features will improve system operational availability, reliability, and mission effectiveness. They will also improve a ship's ability to meet its capstone requirements.

As of late April 2000, initial RNSSMS production systems were delivered for installation aboard LHD 7 and CVN 68. In May 2000, the system's software began LHD class configuration combat system level testing at the Navy's Integrated Combat System Test Facility in Point Loma, California, to be completed by October 2000. The current RNSSMS program schedule, which includes integration testing with SSDS MK II, provides the first fully operational systems on LHD 7 in April 2001 and on CVN 68 in December 2001. RNSSMS hardware installations in CVN 76 and 69 are planned during fiscal years 2000 through 2002. The Navy also plans to install the system on the entire LHD ship class, all remaining CVN ships, and one conventional carrier (CV 67) between 2003 and 2006. The RNSSMS is intended to help pave the way for the next generation of self-defense systems.

Evolved Sea Sparrow Missile (ESSM): ESSM is an improved version of the RIM-7 missile with a new rocket motor, associated tail control section, new warhead, and guidance upgrades. A faster missile with an improved payload and range, the ESSM will have enhanced capability to destroy next generation anti-ship cruise missiles. The ESSM is an international cooperative effort being designed to operate with current and future fire control systems and with the capability of being fired from three existing missile launchers.

In December 1997, an ESSM blast test vehicle was successfully fired from an industry developed prototype that utilized a MK 41 Vertical Launching System Quad Pack cannister. In March 1998, a test firing that utilized a MK 48 Guided Vertical Launching System was successfully conducted. In mid-1998, however, the program began experiencing technical problems. The technical problems involved the new digital autopilot software and the control actuator assembly in the missile. The autopilot software had to be redesigned causing a program delay of about nine months. Concurrently, efforts were expended to modify the control actuator assembly. Collectively, both problems resulted in a program delay of 13 months and a U.S. cost growth of about $22 million.

In November 1999, the ESSM program conducted a test firing that did not achieve all required objectives. Upon investigation, the program office learned that a control actuator assembly was missing a critical component. During the next scheduled test firing in March 2000, the test firing was successful, accomplishing all remaining controlled test vehicle objectives and initial guided test vehicle objectives. A test firing for the guided test vehicle is scheduled for July 2000. The next major milestone is a Program Management Review for low rate initial production, scheduled for September 2000.

Rolling Airframe Missile (RAM) Block 0: RAM is a NATO cooperative program with Germany. Memorandums of Understanding between the United States and Germany have been signed for the development and production of the RAM Block 0 as well as for the development of RAM Block I. The RAM Block 0 weapon system consists of a 21-round missile launcher, below-deck electronics, and a guided missile round pack. The round pack consists of a 5-inch, supersonic missile and launching canister, which interfaces the missile and the launcher. The Block 0 missile is a dual mode, radio frequency/infrared seeking autonomous homing missile that initially guides on the threat missile's radar signature prior to transitioning to infrared guidance. In May 1993, the Assistant Secretary of the Navy for Research, Development, and Acquisition approved RAM Block 0 for production. Subsequently, the missile has had successful intercepts in 127 of 132 production proofing and ship qualification test flights in both the U.S. and German navies.

Since 1993, the RAM Block 0 has been installed on all five LHA ships, eight DD 963 ships, six LHD ships, and eight LSD class ships. Navy installation plans call for RAM Block 0 installations in one DD 963 class ship and on LHD 7 (currently under construction). All other planned RAM installations call for the RAM Block I configuration.

Rolling Airframe Missile Block 1: The Block I upgrade provides the RAM missile with an increased capability to intercept cruise missiles by means of an infrared only acquisition technique. Based on the results of operational testing conducted aboard the U.S.S. *Gunston Hall* (LSD 44) in January 1999 and the Self-Defense Test Ship between March and August 1999, the Commander, Operational Test and Evaluation Force, declared the RAM Block I to be operationally effective against a variety of cruise missile threats and recommended fleet introduction. The Block I missile had successful intercepts in 23 of 24 development test firings. A full-rate production decision occurred in January 2000.

As of March 2000, RAM Block I has been installed on two LSD class ships and is pending installation on two LSD 41 class ships, LHD 7, and CVN 76. Navy installation plans call for Block I installations or upgrades on 8 LSD 41/49, 3 DD 963, 12 CV/CVN, 7 LHD, and 12 LPD 17 (new construction) ships between 2001 and 2006. Though not yet funded, the Navy also plans to install RAM Block I upgrades on all five LHA class ships during fiscal year 2007.

In November 1998, the United States and Germany amended the Block I development Memorandum of Understanding to include scope and funding for the development of a helicopter/aircraft/surface craft (HAS) upgrade of the RAM missile. Requiring only software changes to the RAM Block I missile, the HAS upgrade will extend RAM targets to include helicopters, aircraft, and surface ships. Navy plans indicate that all RAM installations on LSDs, LHDs, LPDs, and CV/CVNs will be the HAS configuration by 2009. Also, the Navy is developing an 11-round guided missile launcher in the HAS mode configuration for installation on CG 52 through 73 between 2004 and 2009.

Phalanx Close-in Weapon System: The Phalanx Close-in Weapon System is a high-fire rate system that automatically acquires, tracks, and destroys enemy cruise missile threats that have penetrated all other ships' defenses. The original Block 0 configuration incorporated on-mount search and track radars, the M61A1 gatling gun capable of firing at a rate of 3,000 rounds per minute, and a 980-round magazine. Subsequent Block 1 baseline 0 upgrades included a larger magazine (1,500 rounds), a multiple pulse repetition frequency search radar, an expanded radar search envelope to counter diving targets as well as reliability and maintainability improvements. Block 1 baseline 1 replaced the hydraulic gun drive with a pneumatic (air-driven) gun drive system that increased the rate of fire to 4,500 rounds per minute. Search radar sensitivity was also improved in the baseline 1 upgrade. Block I baseline 2 introduced further reliability upgrades and a muzzle restraint to decrease dispersion. Installed on multiple non-Aegis and Aegis ships, neither the original Phalanx Block 0 nor the subsequent Block 1 baseline 0, 1, or 2 upgrades are integrated with a ship self-defense system.

The Phalanx Block 1A incorporates a high-order language computer and provides improved performance against maneuvering targets. Block 1A also provides for basic integration with the Ship Self Defense System and enables RAM missile engagement through the Phalanx detection and track function. As of mid-March 2000, Block 1A installations have been completed on 20 DDG (Aegis) destroyers, 2 LHD, 2 FFG-7, and 9 LSD 41/49 class ships. In addition, LHD-7 (currently under construction) will commission with Block 1A. A January 1992 Chief of Naval Operations decision requires replacement of Phalanx with the new ESSM system in new construction DDG ships. Though it initially appeared that DDG-79 would be the first new construction DDG to receive Evolved Sea Sparrow Missile in lieu of Phalanx, it now appears that, due to a slippage in the ESSM development program, DDG-85 will be the first. The Navy plans to install the Phalanx Block 1 baseline 2 configuration as temporary installations on DDG-79 through 84 until ESSM is produced.

The Phalanx Block 1B upgrade allows engagement of small, high-speed, maneuvering surface craft and low, slow aircraft. This upgrade incorporates a thermal imager, an automatic acquisition video tracker, and a stabilization system for the imager, providing both day and night detection of threats. The thermal imager also improves the system's ability to engage anti-ship cruise missiles by providing more accurate angle tracking information to the fire control computer. Operational evaluation of Block 1B, conducted aboard U.S.S. *Underwood* (FFG-36) and the Self-Defense Test Ship, was completed in August 1999. According to Phalanx Program Office plans, Block 1B will be installed in 11 other FFG-7 CORT ships between June 2000 and July 2002.

Decoys: Decoys are an integral component of current ship self-defense efforts. Deployed in conjunction with electronic warfare systems and passive countermeasures, chaff and infrared distraction decoys are an effective adjunct to hard kill weapons. Used to launch both chaff and infrared decoys, the MK 36 decoy launching system is the primary decoy launcher in the fleet today. The MK 36 decoy launching system is found on the following ship classes: LSD 41/49, LHD, LPD 4, LHA, FFG 7, DD 963, DDG 47, CG 47, and AOE 1/6.

The Offboard Active Decoy (NULKA): NULKA is a joint cooperative program between the U.S. and Australia to develop an active, off-board, ship-launched decoy. The NULKA decoy uses a broadband radio frequency repeater mounted on a hovering rocket platform to defeat advanced sea-skimming/high diving anti-ship cruise missiles. After launch, the decoy radiates a large, ship-like radar cross-section signal while flying a trajectory that lures the attacking missile away from the ship. In September 1996, the Navy modified its existing Mk 36 decoy launching system to a new MK 53 system that is capable of launching NULKA decoys.

In May 1995 the U.S. Navy, on behalf of the Joint Project Office, awarded an engineering and manufacturing development contract to build 13 prototype NULKA decoys. Based on successful contractor qualification tests, the U.S. Navy authorized the Royal Australian Navy to award an initial production contract in June 1997 that included 52 NULKA decoys for U.S. Navy use. During October 1997 development tests aboard the U.S.S. *Stump* (DD 978), the program encountered technical problems with two of three launched decoys. In response, the Joint Project Office officials initiated an in-depth analysis of the contractor's production facilities. Upon finding quality control and production management problems, the contractor corrected the problems. During the summer of 1998, successful developmental and operational tests were conducted aboard the U.S.S *Peterson* (DD 969).

In January 1999, the Commander, Operational Test and Evaluation Force, assessed NULKA and the MK 53 decoy launching system as potentially effective and suitable, and he recommended limited fleet introduction with additional follow-on test and evaluation requirements. As a result, a production contract for 11 MK 53 launch systems was awarded in February 1999. As of January 2000, four systems had been installed on Ticonderoga class cruisers. The remaining seven systems are to be installed in fiscal year 2000 on four other Ticonderoga class cruisers and two Arleigh Burke class destroyers. One system is designated for use as a trainer.

Under Navy installation plans dated January 2000, an additional 47 launching systems will be installed on 14 Ticonderoga class cruisers, 29 Arleigh Burke class destroyers, and 4 LSD 41/49 class ships between fiscal years 2001 and 2006. Also during this period, an additional 20 NULKA systems will be delivered for new construction installations on 9 LPD 17 and 11 Arleigh Burke class ships. NULKA development efforts are ongoing to integrate NULKA with the Navy's future SSDS MK II and AIEWS systems.

Completed, Ongoing, and Planned Improvements in Self-Defense Capability by Ship Class

Ticonderoga (CG-47) Class Cruisers

There are 27 ships in this class, and each has a crew of 364. These ships can be used to provide area air defenses for carrier battle groups or amphibious ready groups. They can operate independently and serve as flagships of surface action groups. They are equipped with the Aegis weapon system that integrates their SPY radar system with the Standard and Tomahawk missiles they normally carry. The Aegis system allows them to detect and engage multiple air targets nearly simultaneously. The earliest planned decommission date for any ship of this class is approximately 2019.

In 1994, the detection systems aboard these ships included a SPS-49 two-dimensional air search radar, a SPY-1A or SPY-1B radar, and the SLQ-32 electronic warfare system. The control function was performed by the Aegis combat direction system. Engagement systems consisted of the Standard Missile II variant and the Phalanx Blocks 0 or 1.

Since 1994, ship self-defense capability improvements have been limited to the installation of the Cooperative Engagement Capability (CEC) system on four ships. In 1999, the Navy had assessed the ship self-defense capability of this class as having moderate to high capability against the near-term threat requirement, moderately capability against the mid-term threat requirement, and low capability against the far-term threat requirement. The Navy's representation of the ship self-defense capability of this class may be overstated as it is based on the assumption that the class is being equipped with the Phalanx Block 1A, but as of September 30, 1999, none of these cruisers has this variant. In addition, the assessment was based on these ships being equipped with the SPY-1B. However, only 15 of the 27 cruisers have this radar variant.

The Navy expects to modernize this cruiser class initially with the SPQ-9B radar, the AIEWS, CEC, the baseline 6 version of the Aegis combat system, an upgraded RAM, and NULKA. The procurements of these self-defense systems are scheduled to occur in fiscal year 2002, and the installations are scheduled for fiscal year 2004. The Navy has determined that these additions would provide high self-defense capability against both the near- and mid-term threat requirements, and moderate capability against the far-term threat requirement.

Arleigh Burke (DDG-51) Class Destroyers

These warships conduct anti-submarine, anti-air, and anti-surface operations in support of carrier battle groups, surface action groups, amphibious groups, and replenishment groups. They are equipped with the

Aegis combat direction system that integrates the SPY-1 radar with the Standard, Tomahawk, and Harpoon Missiles; torpedoes; and Phalanx. The Navy has 28 of these ships and plans to build 30 more. Each ship has a crew of about 323. The earliest planned decommission date for any ship in this class is approximately 2026.

In 1994, the self-defense configuration for these destroyers included the SPY-1D radar and the SLQ-32 electronic warfare system. The control function was performed by the Aegis combat system. Engagement systems consisted of the Standard Missile II variant and the Phalanx Block 1.

Since 1994, the ship self-defense capability on this class of destroyers has been limited. In 1999, the Navy had assessed the ship self-defense capability of this class as having moderate capability against the near-term threat requirement, low to moderate capability against the mid-term threat requirement, and low capability against the far-term threat requirement. The Navy's representation of the ship self-defense capability of this class may be overstated with regard to its weapon systems. The assessment is based on the assumption that the class has been equipped with the Phalanx Block 1A, but as of September 30, 1999, only 13 of the 28 destroyers in the fleet have this variant. Alternatively, the assessment assumed that the destroyers were equipped with only the electronic support version of SLQ-32, when in fact 11 of the 28 destroyers in the fleet are equipped with the upgraded electronic warfare version of SLQ-32.

The Navy expects to upgrade DDG 51-78 with CEC, the baseline 6 version of the Aegis weapon system, an upgraded Standard Missile II variant, and NULKA. The Navy plans to install the ESSM on DDG 79 and subsequent ships. The Navy expects these upgrades to give these ships a high capability against both the near- and mid-term threat requirements and moderate capability against the far-term threat requirement.

Oliver Hazard Perry (FFG-7) Class Frigates

These ships operate primarily as anti-submarine warfare combatants for protecting amphibious expeditionary forces, underway replenishment groups, and merchant convoys. They also have a limited anti-air warfare capability. These ships cost less than cruisers and destroyers, but lack the multi-mission capability needed by modern surface combatants against multiple, high-technology threats. They also offer limited capacity for growth. Despite their limitations, they are capable of withstanding considerable damage. The ship's survivability was demonstrated when the U.S.S. *Stark* was hit by two Exocet cruise missiles in 1987. The ship survived, was repaired, and returned to the fleet. Frigates carry helicopters, missiles, torpedoes, a gun, and Phalanx. There are 36 ships in this class and each has a crew of about 300. Seven of the 36 ships in this class are planned for decommissioning by fiscal year 2003.

In 1994, the self-defense configuration for the Oliver Hazard Perry class frigates included the SPS-49 radar, the STIR/CAS system, and the SLQ-32 electronic support system. The MK 92 performed the control function. Engagement systems consisted of the Standard Missile I variant and the Phalanx Block 0 or 1.

Since 1994, ship self-defense capability improvements have consisted of the installation of RAIDS. In 1998, the Navy had assessed the ship self-defense capability of this class as having low capability against the near- and mid-term threat requirements. Although there are 36 ships in this class, the Navy has focused its attention for ship self-defense improvements on the 12 CORT[1] ships. Accordingly, only the 12 CORT ships received the RAIDS system. Additionally, some of the CORT ships have received radar and electronic warfare upgrades. Additionally, the Navy plans to add Phalanx Block 1B to the 12 CORT ships by July 2002. The non-CORT ships were not assessed because of their short remaining service life.[2] The Navy projected the self-defense capability of frigate class ships to be low against the near- and mid-term threats.

Spruance (DD-963) Class Destroyers

The primary mission of these ships is anti-submarine warfare. They are completing a long-term modernization program during which they will have received SH-60B helicopters, Tomahawk missiles, and Phalanx. Adding the Tomahawk has greatly expanded their role in strike warfare. There are 24 ships in this class, and each has a crew of 382. The Navy plans to decommission 11 ships in this class between 2001 and 2005 and the remaining 13 ships between 2006 and 2009.

[1]CORT stands for Coherent Receiver and Transmitter and refers to the Mk 92 Mod 6 weapons control system. The Navy upgraded the Mk 92 Mod 2 system to the Mod 6 system, along with upgrades to radars and processors on 12 frigates. These 12 CORT frigates have improved detection and tracking capability.

[2]P. L. 105-56, section 8053, found at 10 USC 2241, note prohibits the Navy from modifying ships that are within 5 years of retirement, unless the Secretary of the Navy waives the prohibition.

In 1994, the self-defense configuration for these destroyers included the MK-23 target acquisition system, the SPS-40 two-dimensional air search radar, and the SLQ-32 electronic support system. The SWY-1 integrator performed the control function by interfacing the MK-23 target acquisition radar with the NATO Sea Sparrow Surface Missile system. The engagement systems consisted of the NATO Sea Sparrow Surface Missile and Phalanx Block 0 or 1.

Since 1994, ship self-defense capability improvements have consisted of the installation of the SWY-3 integrator with RAIDS and the RAM Block 0. In 1998, the Navy had assessed the ship self-defense capability of this class as being moderate relative to meeting the near-term threat requirement and low relative to meeting the mid-term threat requirement. The Navy's representation of the ship self-defense capability of this class may be overstated as it is based on the assumption that the class has been equipped with the RAM Block 0, but as of September 30, 1999, only 7 of the 24 ships had this missile. According to its future upgrade plans, the Navy expects to add the NULKA to the entire ship class and RAM Block 1 to three ships in this class, thus providing them with a moderate to high capability to meet the near-term threat requirement and a moderate capability to meet the mid-term missile threat requirement.

Nimitz Class Nuclear Aircraft Carriers

The Navy's 8 Nimitz class nuclear powered aircraft carriers provide sustainable, independent forward presence and conventional deterrence in peacetime; operate as the cornerstone of joint/allied maritime expeditionary forces in times of crisis; operate and support aircraft attacks on enemies; and protect friendly forces and engage in sustained independent operations in war. Carriers support and operate aircraft that engage in attack on airborne, afloat, and ashore targets that threaten free use of the sea and engage in sustained operations in support of other forces. They are the largest warships in the world, are powered by two nuclear reactors, and carry 85 aircraft. The crew consists of a ship's company of 3,200 and an air wing of 2,480.

In 1994, the self-defense configuration for Nimitz class carriers included the SPS-49 two-dimensional radar, the SPS-48E three-dimensional radar, MK-23 target acquisition system, and the SLQ-32 electronic warfare system. The SWY-1 integrator performed the control function by interfacing the MK-23 target acquisition radar with the NATO Sea Sparrow Surface Missile.

Engagement systems consisted of the NATO Sea Sparrow Surface Missile and the Phalanx Block 1.

Since 1994, ship self-defense capability improvements have consisted of the installation of Advanced Combat Direction System (ACDS). This system integrates with the SWY-1 in performing the control function. In 1998, the Navy had assessed the ship self-defense capability of this class as being low against the near-, mid-, and far-term threat requirements. The Navy's representation of the ship self-defense capability is based on the assumption that the ships in the class had been equipped with the ACDS Block 1. As of September 30, 1999, only one of the eight ships had ACDS Block 1, six ships had Block 0, and one ship was being overhauled. When the overhaul of this ship is complete, it will have both SSDS MK II and ACDS Block 1.

According to its future plans, the Navy expects to upgrade the detect systems to include the SPQ-9B and the Cooperative Engagement Capability, the control system to include the SSDS MK II, and the weapon systems to include the RAM Block 1 and the Rearchitectured NATO Sea Sparrow Surface Missile System. This upgrade is planned for CVN 76; however, the capability of CVN 77 is being negotiated. By adding these systems, the Navy believes that the ship self-defense capability of these carriers will be moderate to high in meeting the near- and mid-term threat requirements and low to moderate in meeting the far-term threat requirement.

Whidbey Island and Harpers Ferry Dock Landing Ships

Dock Landing Ships (LSD) have the ability to flood a well deck to make possible the loading at sea of various types of amphibious craft and vehicles and their cargoes. The LSD 41 class, designed specifically to handle four Landing Craft Air Cushion (LCAC), can also accommodate 22 officers, 391 enlisted sailors, and 402 Marine Corps troops. Commissioned in 1985, the U.S.S. *Whidbey Island* became the first ship of this class. Between 1986 and 1992, the Navy added seven ships to this class. In 1987, the Navy requested funding for a cargo variant that differed from the original LSD 41 by reducing its number of landing air cushion craft to two in favor of additional cargo capacity. The first cargo variant, the U.S.S. *Harpers Ferry* (LSD 49), was delivered in 1994. The remaining three LSD 49 class ships were delivered between 1995 and 1998. The LSD 49 class has the same crew capacity, as does the LSD 41 class.

As of October 1994, self-defense configurations for the combined LSD 41/49 class included the SPS-49 air search radar and the SLQ-32 electronic warfare system. Though the control function was being performed manually throughout the class, the Navy completed operational testing of an automated control system (SSDS MK I) in June 1997 aboard the U.S.S. *Ashland* (LSD 48). Engagement relied primarily upon Phalanx Block 0 or 1 and the Mk 36 decoy launching system. As measured by the Navy's performance assessment model, this configuration produced a performance result that was far below the threat requirements for the class.

Since October 1994, the Navy has taken several actions to enhance the LSD 41/49 class's ability to defeat cruise missiles. The Navy enhanced detection capabilities by adding a medium pulse repetition frequency upgrade to the SPS-49 radar and integrating the Phalanx radar with the control system. To improve the control function, the Navy installed SSDS MK I on four LSD 41 and two LSD 49 class ships. In addition, to improve engagement capabilities, the Navy completed installations of the Phalanx Block 1A upgrade on six LSD 41 and two LSD 49 class ships. In addition, RAM Block 0 was installed on five LSD 41 and three LSD 49 class ships. With these installations, the Navy more than doubled the class's ability to counter current and future missile threats since requirements were adopted in February 1996. However, additional improvements in capability are needed to meet requirements for near-, mid-, and far-term threats.

Two recent development efforts, RAM Block 1 and NULKA, are planned for future installation in the LSD 41/49 ship class. Once installed, the Navy expects that these improvements will provide these ships with a high capability against the near-term threat, moderate to high capability against the mid-term threat, but a low capability against the far term threat.

Landing Helicopter Assault Ships

Landing Helicopter Assault (LHA) ships serve as primary landing ships for assault operations of Marine expeditionary units. These ships use conventional landing craft and helicopters to move Marine assault forces ashore. In a secondary role, these ships also use AV-8B Harrier aircraft and anti-submarine warfare helicopters to perform sea control and limited power projection missions. Commissioned in 1976, the U.S.S. *Tarawa* (LHA 1) became the first ship of this amphibious class. Between 1977 and 1980, the Navy added four more ships to this class. LHA class ships can accommodate 82 officers, 882 enlisted sailors, and 1,900 Marine Corps troops.

As of October 1994, LHA class ships were outfitted with the SPS-40E air search radar, the MK 23 target acquisition system, and the SLQ-32 electronic warfare system as detection elements. Also, installation of the SPS-48E radar was complete on three ships. Control functions were performed by the SWY-2 integrator, which interfaced the MK 23 target acquisition radar with the RAM Block 0 weapon system. Engagement elements included RAM Block 0, Phalanx Block 0, and the MK 36 decoy launching system. This defense configuration produced a performance result that was below the capstone requirements for the class.

Since October 1994, Navy staff made only a few defensive improvements to the LHA class. Specifically, they completed installations of the SPS-48E radar and the Phalanx Block 1 on all five LHA ships. In addition, they installed the Advanced Combat Direction System Block 0 on three ships. These improvements, however, provided little overall improvement in the class's ability to meet the capstone requirements.

In October 1998, the Navy considered implementing a Service Life Extension Program to this class; however, there are no current plans to do so. Beginning in fiscal year 2001, the Navy plans to conduct an analysis of alternatives study to determine the preferred choice between a modification to the LHD class design or a brand new hull configuration, currently known as the LH(X) class.

Landing Helicopter Dock Ships

Landing Helicopter Dock (LHD) ships are the Navy's new class of amphibious assault ships to support a Marine landing force. These ships can accommodate three landing craft, AV-8B Harrier aircraft, and the full range of Navy and Marine Corps helicopters. Commissioned in 1989, the U.S.S. *Wasp* (LHD 1) is the lead ship of this new class of multipurpose amphibious assault ships. Between 1992 and 1998, the Navy added five more LHD ships to its fleet. LHD class ships can accommodate 104 officers; 1,004 enlisted sailors; and 1,894 Marine Corps troops.

As of October 1994, three LHD class ships had been delivered to the fleet. The fourth LHD ship was commissioned in February 1995. These first four LHD ships were outfitted with the SPS-48E and SPS-49 air search radars, the MK 23 target acquisition system, and the SLQ-32 electronic warfare system as detection elements. The ACDS integrated with the AN/SWY-1 performs threat assessment and weapons control. Engagement elements included the NATO Sea Sparrow Surface Missile, Phalanx Block 1, and the

MK 36 decoy launching system. This defense configuration produced a performance result that was below the capstone requirements for the class.

Two additional LHD class ships were delivered to the fleet in 1997 and 1998. These ships were delivered with ACDS and the AN/SWY-3 control configuration. This integrated capability/configuration included the MK 23 Target Acquisition System and multiple NATO Sea Sparrow Surface and RAM missile systems. No LHDs are slated to receive RAM Block 1 until late fiscal year 2002, with LHD 5 and 6 slated for fiscal year 2006 and 2007, respectively. The Navy assessed that this improvement provided the ship class with a high capability against the near- and mid-term threat and a moderate capability against the far-term threat.

The U.S.S. *Iwo Jima* (LHD 7), currently in production, is being outfitted with the AN/SPS-48E and the AN/SPS-49 MPU radar, MK 23 Target Acquisition System, ACDS, an AN/SWY-3 configuration, and Phalanx Block 1A. The Navy plans to improve the AN/SWY-3 capability in late fiscal year 2002 by an upgrade of the MK 23 Target Acquisition System and incorporation of RAM Block 1. These improvements should enable the U.S.S. *Iwo Jima* to have moderate to high capability against near- and mid-term threats. The U.S.S. *Iwo Jima* is also slated to receive a Mission Force Protection upgrade in the 2006-2009 time frame.

Amphibious Transport Dock Ships

Amphibious Transport Dock (LPD) ships serve primarily to transport and land Marines, their equipment, and supplies for amphibious operations. The Navy currently has 11 LPD class ships in commission, but the ships are nearing the end of their service life. For example, the oldest ship, the U.S.S. *Austin* (LPD 4) turned 35 in February 2000. Moreover, these ships are especially vulnerable to cruise missile attack as their defensive capabilities consist of only two Phalanx weapon systems. The Navy plans to replace its current LPD fleet, as well as other old amphibious ships, with its newest class of amphibious ship—the LPD 17. The new LPD 17class ship is being designed to accommodate 32 officers, 463 enlisted sailors, and 720 Marine Corps troops.

In June 1996, the Navy received approval to enter into the engineering and manufacturing development phase of its LPD 17 program and to produce the first three of a low-rate initial production quantity of 12 ships. The baseline design included the following configuration—SPS-48E, SPQ-9B, and SLQ-32 or AIEWS (if matured for production) as detection elements; CEC and SSDS MK 2 as control element; and RAM Block 1, NULKA, and the new Evolved Sea Sparrow Missile (ESSM) with a vertical launch system as engagement elements. As projected by the Navy's performance assessment model, this configuration would have high capability against the near- and mid-term threat and moderate capability against far-term threat.

The Navy realized that the ESSM program schedule would not coincide with the production schedule of the first two ships in the class and decided to reserve space and weight in the ship design for the missile system and launcher for subsequent installation in these two ships. However, the Navy planned to equip the remaining 10 ships in the class with the ESSM system during their production. In 1998, various congressional committees directed the Navy to prepare an analysis of alternatives to the LPD 17 baseline design, including an evaluation of the AN/SPY-1 radar and its associated Aegis combat system, multifunction radar, and the ESSM. The March 1999 results of the Navy analysis confirmed that the baseline design without the ESSM could meet the near- and mid-term threat at the least cost. As a result of this assessment, the Navy withdrew funding for the ESSM system from the LPD 17 budget for fiscal years 2000–2003, and applied those funds to its cruiser conversion program and other shipbuilding and conversion activities. This action resulted in deletion of the ESSM and its vertical launching system from the remaining 10 ships, with only a space and weight reservation for an eventual backfit.

The Navy will review the LPD 17 combat system in 2001 to determine if changes in configuration are warranted. The costs and benefits of including a multi-function and volume search radar in the LPD 17 combat system suite will be considered in this review.

Fast Combat Support Ships

The fast combat support ship (AOE) is the Navy's largest combat logistics ship. Its mission is to receive ammunition, provisions, stores, and petroleum products from shuttle ships, and to distribute them to carrier battle groups while underway. Commissioned in 1964, the U.S.S. *Sacramento* (AOE 1) became the first ship of this class. Between 1967 and 1970, the Navy added three more AOE 1 class ships to its fleet. In 1987, Congress appropriated funds for the next generation AOE class ship. The lead ship, U.S.S. *Supply* (AOE 6), was commissioned in 1994. Three more AOE 6 ships were delivered between 1995 and 1998. AOE 6 class ships can accommodate 40 officers and 627 enlisted sailors.

As of October 1994, self-defense configurations for the combined AOE 1/6 class included the MK 23 target acquisition system and the SLQ-32 electronic warfare system. Control functions were performed manually. Engagement elements included NATO Sea Sparrow Missile system, the Phalanx Block 0 or 1, and the MK 36 decoy launching system. This defense configuration produced low capability against all threat requirements. With the exception of minor technical changes, Navy staff has made no ship self-defense improvements to either AOE ship class since October 1994.

Staff of the Chief of Naval Operations and fleet commanders are currently weighing alternatives for the future of the AOE 1 and AOE 6 class ships. In December 1996, the Navy estimated that it would cost $450 million to extend the service life of the four AOE 1 ships to the year 2010. In February 1997, the Chief of Naval Operations tasked Navy program staff to identify the minimum requirements needed to keep the AOE 1 class operational until the year 2010. In response, type and group commander staff, engineers, ship commanding officers, and members of the Navy Sea Systems Command technical community reached consensus on what came to be called the AOE 1 Class Sustainability Program, with an estimated cost of $103 million. A teaming effort among the Naval Sea Systems Command and Navy type commanders has, to date, accomplished many of the work items associated with the Sustainability Program. Of the remaining program balance of $60.6 million, $9.6 million is currently funded in the future years defense plan, leaving an unfunded balance of $51 million. However, none of the work items included in the AOE 1 Class Sustainability Program will improve the class's level of ship self-defense.

Since at least 1997, the Navy has been considering the possibility of transferring its AOE 6 ship class to the Military Sealift Command. At the present time, no ship self-defense upgrades are being planned or recommended, according to Navy officials.

Comments From the Department of Defense

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ACQUISITION AND
TECHNOLOGY

12 JUN 2000

Mr. James F. Wiggins
Associate Director, Defense Acquisition Issues
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Wiggins:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "Defense Acquisitions: Comprehensive Strategy Needed to Improve Ship Cruise Missile Defense," dated May 10, 2000 (GAO Code 707424/OSD Case 2001). The Department concurs with the need for a comprehensive strategy to improve ship cruise missile defense.

The report provides an accurate assessment of the Navy's ship self-defense situation. The Navy is making progress in improving surface ship self-defense capabilities against near-term and mid-term threats; however, projected capability against far-term threats is marginal. The Department concurs that without a well-documented comprehensive strategy for improving its capabilities, and a commitment to fund associated R&D, efforts to develop technological solutions needed to defeat projected far-term threats will be limited.

Competing priorities over the past four years has made it difficult for the Navy to execute its investment plan for ship self-defense. A comprehensive strategy that communicates priorities and defines required resources will serve as a useful tool for better aligning available resources.

The Navy models used to assess performance capability are based on documented fleet data, and apply certain global assumptions uniformly across the board. By comparing performance with and without particular improvements, Navy decision-makers can make consistent choices. Nonetheless, the Department will request the Navy re-evaluate whether assumptions used in these models reflect the reality of fleet operations, including weather conditions, and crew and equipment performance and availability.

The Navy is developing a written Maritime Force Protection Strategic Plan that will also be made available to the GAO in response to the recommendation.

A response to the GAO recommendation is enclosed. Detailed comments to the draft report have been provided separately.

The Department appreciates the opportunity to comment on the draft report.

Sincerely,

George R. Schneiter
George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure

GAO DRAFT REPORT DATED MAY 10, 2000
(GAO CODE 707424) OSD CASE 2001

"DEFENSE ACQUISITIONS: COMPREHENSIVE
STRATEGY NEEDED TO IMPROVE SHIP CRUISE
MISSILE DEFENSE"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION

Now on p. 22.

RECOMMENDATION: The GAO recommends that the Secretary of Defense direct the Secretary of the Navy to develop a comprehensive strategy that clearly articulates priorities, establishes baselines, provides timelines, and defines resource requirements for achieving required capabilities. (p. 16/Draft Report)

DOD RESPONSE: The Department concurs with the GAO recommendation and will submit a written request to the Navy within 30 days after release of the final GAO report. The Navy will also be requested to re-evaluate whether assumptions used in performance assessment models reflect the reality of fleet operations.

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