



April 2017

LITTORAL COMBAT SHIP AND FRIGATE

Delaying Planned Frigate Acquisition Would Enable Better- Informed Decisions

GAO Highlights

Highlights of [GAO-17-323](#), a report to congressional committees

Why GAO Did This Study

The Navy envisioned a revolutionary approach for the LCS program: dual ship designs with interchangeable mission packages intended to provide mission flexibility. This approach has fallen short, with significant cost increases, schedule delays, and reduced capabilities—some of which have yet to be demonstrated. The LCS acquisition approach has changed several times. The latest change led to the frigate—a ship that involves minor modifications to an LCS design.

The House report 114-537 for the National Defense Authorization Act for Fiscal Year 2017 included a provision for GAO to examine the Navy's plans for the frigate. This report examines the Navy's plans for the frigate acquisition as well as remaining opportunities for oversight. To conduct this work, GAO reviewed documentation and interviewed Department of Defense (DOD) officials, and leveraged prior GAO reports on shipbuilding and acquisition best practices.

What GAO Recommends

Congress should consider not enacting authority pursuant to the Navy's request for a block buy of 12 frigates in fiscal year 2018 and delaying funding of the lead frigate until at least fiscal year 2019, when more information is available on the ship's cost, design, and capabilities. GAO also recommends that DOD delay its procurement plans until sufficient knowledge is attained. DOD partially concurred with the recommendation but is not planning to delay frigate procurement. GAO continues to believe the recommendation is valid.

View [GAO-17-323](#). For more information, contact Michele Mackin at (202) 512-4841 or mackinm@gao.gov.

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Delaying Planned Frigate Acquisition Would Enable Better-Informed Decisions

What GAO Found

The Navy's current acquisition approach for its new frigate—a ship based on a Littoral Combat Ship (LCS) design with minor modifications—requires Congress to make significant program decisions and commitments in 2017 without key cost, design, and capability knowledge. In particular, the Navy plans to request authority from Congress in 2017 to pursue what the Navy calls a block buy of 12 planned frigates and funding for the lead ship, which the Navy intends to award in 2018. Approval of these plans would effectively represent the final decision for the entire planned buy of 40 LCS and frigates. According to the Navy's approved acquisition strategy, the frigates would still require annual appropriations, so Congress would maintain its oversight through its annual appropriation decisions; however, any decision to reduce or delay the program, should that become warranted, could nevertheless be more difficult as the Navy may point to losses in favorable block buy prices, as has been done previously with LCS.

The Navy's impending request presents a key opportunity for Congress to affect the way forward for the frigate program by ensuring the Navy possesses sufficient knowledge on cost, design, and capability before authorizing an investment of a potential \$9 billion for a program that

- has no current formal cost estimate—*independent or otherwise*,
- will not begin key detail design activities until late fiscal year 2018,
- has significant unknowns in regards to operational performance of the ship upon which its design will be based, and
- based on the existing and planned shipyard workloads, has no industrial base imperative to begin construction in the Navy's planned time frame.

The Navy's previous frigate acquisition plans included achieving a higher degree of ship design knowledge before awarding the lead ship in fiscal year 2019, as the plans included significant detail design activities prior to contract award. As GAO has previously found, such an approach—which has been supported by shipbuilders—offers greater confidence in the understanding of design changes and how they will affect ship construction costs. Further, as GAO's work on best practices for program cost estimates suggests, the Navy's prior plans for frigate design efforts and an award in fiscal year 2019 would have provided more information on which to base a decision, including a better understanding of risks and costs. The previous plans also better aligned with LCS test plans to improve the department's understanding of the operational capability and limitations for each ship variant. This knowledge could then be used to inform the Navy's decision on which LCS-based design for the frigate it will pursue. In addition to the valuable knowledge to be gained by not pursuing the frigate in the planned 2018 time frame, the existing and planned LCS construction workload for both shipyards is another important factor to consider. Specifically, each shipyard has LCS construction demands that extend into 2021, suggesting no imperative for the Navy to award the frigate in 2018. Delaying the frigate award until at least fiscal year 2019—when more is known about cost, design, and capabilities—would enable better-informed decisions and oversight for this potential \$9 billion taxpayer investment.

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Abbreviations

DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
LCS	Littoral Combat Ship

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April 18, 2017

Congressional Committees

The Navy initially envisioned a revolutionary approach to the Littoral Combat Ship (LCS) program. Unlike other surface combatant programs, LCS consists of two different ship design variants (called seaframes) built by two separate shipyards. The ships have interchangeable mission packages carrying equipment for three mission areas—surface warfare, anti-submarine warfare, and mine countermeasures. To execute the program, the Navy deviated from traditional shipbuilding acquisition in hopes of rapidly delivering ships to the fleet. The consequences of this approach are well known today—costs to construct the ships have more than doubled from initial expectations, with promised levels of capability unfulfilled and deliveries significantly delayed. Since 2014, two Secretaries of Defense have stepped in to address concerns with the combat capability of LCS. First, Secretary Chuck Hagel questioned the appropriate capability and quantity of the LCS in February 2014 and directed the Navy to re-evaluate its small surface combatant capability needs. Acknowledging capability and affordability concerns, the Navy—with the Secretary of Defense’s approval—then changed course in late 2014 to pursue an LCS with minor modifications, now called a frigate.¹ Second, in December 2015 Secretary Ashton Carter, expressing concern that the Navy had prioritized ship quantities over delivering combat capability, directed the Navy to reduce the total purchase of LCS and frigates from 52 to 40 ships.

Today, with 28 LCS delivered, under contract, or funded, the Navy plans to wind down the LCS program—with the last contract awards expected in 2017—and pivot to acquisition of the frigate. In 2018, the Navy plans to select one of the two LCS shipbuilders—referred to as a downselect—to construct the frigate, and will ask Congress this year to authorize acquisition plans for 12 frigates and funding for construction of the lead ship. The House Armed Services Committee report on a bill for the National Defense Authorization Act for Fiscal Year 2017 included a

¹The term “frigate” can be applied to ships of different sizes and capability. The now-retired Oliver Hazzard Perry-class frigate (FFG 7) was the last U.S. Navy frigate. Frigates—including the FFG 7—have been identified as typically being open-ocean, multi-role ships capable of performing surface, anti-submarine, and anti-air warfare.

provision for us to examine the Navy's plans for the frigate.² This report assesses (1) the extent to which the frigate's planned capabilities offer improvements, if any, over the LCS; and (2) the Navy's plans for the frigate acquisition as well as remaining opportunities for oversight.³

To conduct our work, we reviewed documentation from and interviewed Navy and other Department of Defense (DOD) officials responsible for overseeing LCS and frigate program management, design, development, acquisition, and testing. This included assessment of plans and activities related to LCS and the frigate. In addition, we leveraged from past GAO reports on the LCS program from 2005 through 2016, as well as from our broader work on Navy shipbuilding and acquisition reform initiatives. Details on prior recommendations related to LCS and the frigate that we made in previously issued reports are included in appendix II. Additionally, more details on the objectives, scope, and methodology for our past work can be found in the issued reports, which are cited in appendix III.

We conducted this performance audit from October 2016 to April 2017 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Under the current LCS program, two shipyards are building an equal number of two different versions of the LCS seaframe: Lockheed Martin builds the Freedom variant at Fincantieri Marinette Marine in Marinette, Wisconsin, and Austal USA builds the Independence variant in Mobile,

²H.R. Rep. No. 114-537, at 21 (2016).

³In addition to this report, we also contributed to two Congressional hearings in December 2016 on LCS and the frigate. GAO's testimony statements are referenced in appendix III.

Alabama.⁴ Table 1 shows the status of LCS seaframe acquisition, including the LCS with minor modifications, referred to as a frigate.

Table 1: Status of Littoral Combat Ship (LCS) and Frigate Production as of January 2017

Hull	Status
LCS 1-8, 10	Delivered.
LCS 9, 11-26	Under contract and in various phases of construction or nearing construction; funded in fiscal years 2012 through 2016.
LCS 27-28	Congress authorized funding; contract awards planned in fiscal year 2017.
Frigate (formerly LCS 29-40)	Navy currently intends to seek authority for what it refers to as a block buy approach to buy 12 frigates and plans to award the lead frigate in fiscal year 2018, with subsequent awards of one or two ships planned each year through fiscal year 2025.

Source: GAO analysis of Navy programmatic and budgetary data. | GAO-17-323

When the Navy first conceived of the LCS in the early 2000s, the concept was that two shipbuilders would build prototypes based on commercial designs. The Navy planned to experiment with these ships to determine its preferred design variant. This experimentation strategy was subsequently abandoned. The Navy determined that, based on cost considerations, it would be impractical to have the two competing shipyards build only one or two ships and then wait for the Navy to complete the period of experimentation before awarding additional contracts. Instead, the Navy opted to continue funding additional seaframes without having completed the planned period of discovery and learning. The Navy has made several other revisions to the LCS acquisition strategy over time, some in response to direction from the Office of the Secretary of Defense. These have included changes over time regarding whether the Navy would downselect to one seaframe design. Although it might be expected that a new acquisition concept would require some adjustments over time, the LCS program has evolved significantly since it began, as shown in figure 1.

⁴Lockheed Martin is the prime contractor for LCS 1 and the odd-numbered seaframes. For LCS 2 and LCS 4, General Dynamics/Bath Iron Works was the prime contractor for the Austal USA-built ships. General Dynamics and Austal USA ended their teaming arrangement in 2010. Austal USA is the prime contractor for the remaining even-numbered seaframes.

Figure 1: Littoral Combat Ship (LCS) Acquisition Strategy Evolution



Source: GAO analysis of Department of Defense data. | GAO-17-323

As figure 1 indicates, the Navy now plans to buy LCS with minor modifications, which it refers to as frigates. This change to the acquisition

strategy followed an analysis in 2014 by a Navy task force (known as the Small Surface Combatant Task Force) that was completed in response to direction from the then Secretary of Defense to identify options for a more capable small surface combatant.⁵

Planned Frigate Capabilities Provide Improvements over LCS, but Will Likely Carry Forward Some LCS Design Limitations

In seeking a frigate concept that would improve upon the capabilities provided by LCS, the Navy selected an LCS concept—referred to as a minor modified LCS. This concept, which Navy leadership believed would offer cost, schedule, and shipbuilding advantages, also was assessed as the least capable option considered for the LCS successor. The Navy has noted that the selected design provides some improvements, such as multi-mission and over-the-horizon missile capabilities, at a relatively lower cost than other options by leveraging the existing LCS shipyards and vendors. However, the Navy's chosen frigate design will presumably carry forward some limitations inherent to its LCS origins, such as space limitations and equipment that has posed maintenance and logistics challenges.

Affordability and LCS Shipbuilding Considerations Were Prevailing Factors in Selecting Minor Modified LCS Design

The Navy's Small Surface Combatant Task Force charged with exploring alternatives to the LCS presented Navy leadership with a number of options, from which the Navy chose the option of a minor modified LCS based on cost, schedule, and industrial base stability factors. As we found in June 2016, the task force concluded that the Navy's desired capability requirements could not be met without major modifications to an LCS design or utilizing other non-LCS designs.⁶ When presented with this conclusion, senior Navy leadership directed the task force to explore what capabilities might be more feasible on a minor modified LCS. In response to this direction, the task force created two additional LCS options with minor modifications. These options provided a multi-mission capability instead of the single-mission capability of LCS and retained the modular mission package characteristic of the LCS program (i.e., ability to more readily swap mission systems in and out). In developing these alternatives, the task force also found that it was feasible to permanently install an over-the-horizon missile to offer longer range surface warfare capability, plus a lightweight towed torpedo countermeasure and multi-

⁵GAO, *Littoral Combat Ship: Need to Address Fundamental Weaknesses in LCS and Frigate Acquisition Strategies*, [GAO-16-356](#) (Washington, D.C.: June 9, 2016).

⁶[GAO-16-356](#).

function towed array sonar to offer some anti-submarine warfare capability.⁷ However, these improvements would still need to be augmented by an LCS surface warfare or anti-submarine warfare mission package to provide the full suite of LCS capability. The task force found that it was not technically feasible to include additional vulnerability capabilities (i.e., capabilities to improve the ship's ability to sustain battle damage and still perform its mission) beyond adding armor protection to some vital spaces. Task force documentation also stated that in developing these alternative LCS options with minor modifications, some capabilities, like speed, had to be traded.

Ultimately, the Navy chose—and the Office of the Secretary of Defense approved—a frigate concept based on a minor modified LCS, despite the task force's findings that it was the least capable small surface combatant option considered. Navy leadership indicated this decision was based on LCS's relatively lower cost and quicker ability to field, as well as the ability to upgrade remaining LCS and maintain stability in the LCS industrial base and vendor supply chain.

Frigate Will Have Improved Capabilities over LCS, but Is Constrained by Its Design Concept

In selecting the minor modified LCS concept, the Navy has made trade-offs in refining the capabilities of the frigate, prioritizing lethality and survivability improvements. The Navy noted that as part of the refinement process, the frigate program office identified additional capacity in the LCS designs that has enabled improvements to the ship's planned capabilities. In particular, the Navy stated that the program office determined that full surface warfare and anti-submarine warfare capabilities could be included in baseline frigate plans, as opposed to the partial capabilities that were found to be possible by the Small Surface Combatant Task Force analysis. Table 2 presents an overview of capability changes the Navy has planned for the frigate, as compared to LCS, and the expected effect of those changes.

⁷The lightweight towed torpedo countermeasure is a towed decoy that emits signals to draw a torpedo away from its intended target. The multi-function towed array sonar is a towed receive array sonar with a deployment and retrieval cable that is used to detect acoustic energy from ships and submarines. Both these systems are planned for the LCS anti-submarine warfare mission package.

Table 2: Planned Frigate Capability Changes

Proposed change	Description	Significance
Switch from single to multi-mission capability	Unlike the Littoral Combat Ship (LCS), the frigate will permanently mount surface and anti-submarine warfare mission packages equipment instead of just a single mission package. The Navy does not plan for the frigate to perform mine countermeasures.	A multi-mission capability was recognized in Navy analysis as a key characteristic of a frigate. A frigate will be able to engage different types of threats at all times, unlike LCS which depends on the mission package embarked.
Improve air warfare systems	Frigate will be equipped with an improved air search radar and defensive countermeasures.	This reduces susceptibility to attacks from air-based threats (e.g. aircraft or missiles). The Navy also is considering these improvements for LCS.
Add armor to vital spaces and magazines. Improve shock hardening in anti-air missile system	Armor reduces vulnerability; intended to lessen risk of magazine detonation. Shock hardening reduces vulnerability of missile system.	LCS already has some armor in these areas; shock hardening is limited to anti-air missile system and its support services. The Navy believes adjusting the concept of operations for the frigate is more cost-effective and feasible than a further increase in armor and shock hardening.
Add over-the-horizon missile system	Frigate will have the ability to carry a minimum of eight over-the-horizon missiles to support surface warfare capability needs.	The capability reduces susceptibility (the degree to which a ship can be targeted and engaged by threat weapons) and increases lethality, giving the frigate the ability to strike surface targets further from the ship than is possible on LCS. Navy has considered equipping later LCS ships with this type of capability, but no decision has been made and the change is not funded.
Upgrade electronic warfare	Frigate electronic warfare projected to reduce susceptibility by improving defensive alert capabilities.	Electronic warfare improvements are necessary in order to pace the evolving threats and are consistent with the Navy's prioritization of increased survivability for the frigate.

Source: GAO analysis of Navy documentation. | GAO-17-323

However, we found in June 2016 that the Navy's planned frigate upgrades will not include significant improvements in certain survivability areas.⁸ Further, the Navy sacrificed capabilities that were prioritized by fleet operators. For example, when asked in engagement sessions by the Small Surface Combatant Task Force, fleet operators consistently prioritized a range of 4,000 nautical miles, but the selected LCS concept with minor modifications was noted to have a minimum range requirement of 3,000 nautical miles. The Navy asserted that it is working with the prospective frigate shipbuilders to achieve a range more consistent with the priorities of fleet operators.

⁸[GAO-16-356](#).

The Director, Operational Test and Evaluation (DOT&E) has noted that the Navy's proposed frigate design is not substantially different from LCS and does not add much more redundancy or greater separation of critical equipment or additional compartmentation, making the frigate likely to be less survivable than the Navy's previous frigate class. Additionally, the Navy plans to make some similar capability improvements to existing and future LCS, narrowing the difference between LCS and the frigate. As we found in June 2016, the proposed frigate will utilize the offensive anti-submarine or surface warfare capabilities that are already part of the LCS mission packages, so while the frigate will have multi-mission capability that LCS lacks, the capabilities of the individual mission packages will be consistent with what is available for LCS.⁹ Though specific details are classified, there are only a few areas where there are differences in frigate warfighting capability compared to the LCS.

Since the frigate will be based on an LCS design, it will likely carry forward some LCS design limitations. For example, LCS is configured to support up to 98 personnel, including core and mission package crew and an aviation detachment. Navy officials have stated that the frigate is being designed for a crew of 130. However, given the space limitations on LCS and the fact that the frigate will be based on one of the two LCS designs, achieving this significant increase in crew size could prove challenging. Additionally, barring Navy-directed changes to key mechanical systems, the frigate will carry some of the more failure-prone LCS equipment, such as some propulsion equipment, and will likely carry some of the LCS-unique equipment that has challenged the Navy's support and logistics chain.

⁹[GAO-16-356](#).

Accelerated Frigate Acquisition Plans Require Significant Procurement Commitments Without Key Cost, Design, and Capability Knowledge

Current acquisition plans for the frigate require Congress and the Navy to make significant decisions and potential future commitments of about \$9 billion—based on early budget estimates—without key program knowledge. The Navy plans to request authority from Congress in 2017 to use what the Navy refers to as a block buy approach for all 12 planned frigates and request funding for the lead frigate as part of the fiscal year 2018 budget request.¹⁰ Because of recent changes to the acquisition approach that hastened the frigate award, the decisions that Congress will be asked to make in 2017 will not be informed by realistic cost estimates or frigate-specific detail design knowledge that helps solidify cost and construction expectations. Further, Congress will not possess critical information on LCS performance in testing that would increase understanding of the operational capability of LCS, which provides the design foundation for the frigate. The Navy's award decision planned for 2018 will be informed by formal cost estimate information, but like Congress, the Navy will lack detail design knowledge and have more limited information on LCS's operational capability than would have been available for the previously planned fiscal year 2019 frigate award. And finally, the current and planned LCS construction demands at both LCS shipyards that extend into 2021 suggest no schedule imperative exists that would require the Navy to request or to receive authority in 2017 for the frigate or to award the lead ship in 2018 as currently planned.

Cost Uncertainty and a Compressed Schedule Impose Risk to Frigate Program

The frigate acquisition plan has undergone notable changes since late 2015, for various reasons. As it now stands, an accelerated schedule effectively prevents the Navy from being able to provide Congress with a current, formal cost estimate for the frigate—independently completed or otherwise—before Congress is asked to make significant commitments to the program. Navy officials previously stated that the frigate is expected to cost no more than 20 percent—approximately \$100 million—more per ship than the average LCS seaframes, though this was an initial estimate.

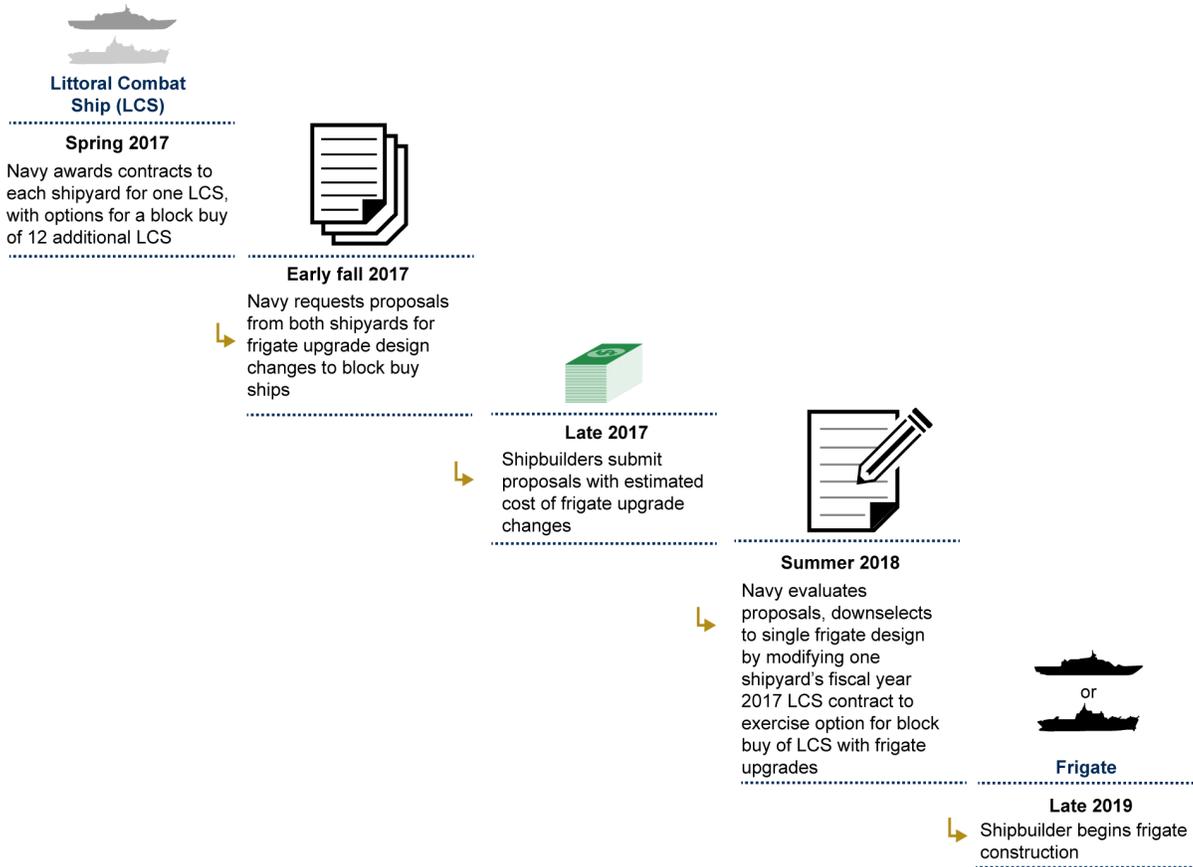
¹⁰The Navy plans to request authority to use what it calls a block buy contract to purchase the frigate—the same contracting approach used for LCS—and funding in the fiscal year 2018 budget request for the lead frigate. Our past analysis of the LCS contracts found that a block buy approach could affect Congress's funding flexibility. For example, the LCS block buy contracts provide that a failure to fully fund a purchase in a given year would make the contract subject to renegotiation, which provides a disincentive to the Navy or Congress to take any action that might disrupt the program because of the potential for the government to have to pay more for ships. If similar terms are included in the frigate contract, the same potential effect may apply.

However, our recent work has shown that LCS under construction have exceeded contract cost targets, with the government responsible for paying for a portion of the cost growth.¹¹ Regarding expected costs for the frigate, prior LCS context is important to consider. When faced with the prospect of a downselect to one LCS variant in 2010, the two shipbuilders provided competitive pricing that propelled the Navy to continue production at both shipyards. Those prices have not yet been achievable.

According to frigate program officials, under the current acquisition approach, the Navy will award contracts in fiscal year 2017 to each of the current LCS contractors to construct one LCS with a block buy option for 12 additional LCS—not frigates. Then, the Navy plans to obtain proposals for frigate-specific design changes and modifications from both LCS contractors in late 2017 that will be used to upgrade the LCS options to frigates. The Navy intends to evaluate pricing and technical factors for the proposed frigate upgrade packages and award frigate construction to one contractor based on a best value determination. This frigate downselect to one of the LCS shipyards is planned to occur in summer 2018. Figure 2 illustrates how the Navy plans to modify the fiscal year 2017 LCS contract to convert the ships in the block buy options to frigates.

¹¹GAO, *Navy Shipbuilding: Need to Document Rationale for the Use of Fixed-Price Incentive Contracts and Study Effectiveness of Added Incentives*, [GAO-17-211](#), (Washington, D.C.: March 1, 2017).

Figure 2: Navy Block Buy Option Contract Modification Process for Frigate Procurement



Source: GAO analysis of Navy data. | GAO-17-323

Navy officials explained that the frigate acquisition plan changed substantially in response to a Secretary of Defense memorandum issued in December 2015 that directed the Navy to revise its LCS and frigate acquisition plans. This included direction to reduce the total number of LCS and frigates from 52 to 40, downselect to one ship design, and award the frigate in fiscal year 2019. The Navy subsequently revised its plans to include a downselect decision, but also decided to accelerate the award of the lead frigate from fiscal year 2019 to 2018 as a replacement for awarding a single LCS in 2018. Table 3 shows the changes that have occurred since that memorandum.

Table 3: Changes in Frigate Acquisition Plans and Number of Ships, 2015-2016

Previous plan (December 2015)	Current plan (October 2016)
Dual contract award in fiscal year 2019	Downselect award to one shipbuilder in summer 2018
20 frigates (10 per shipbuilder)	12 frigates
Government-led, prescribed design	Contractor-driven design process based on build specifications; increased government furnished equipment
Multiple frigate upgrade packages, with a fiscal year 2019 bid to mature frigate design	Single frigate upgrade package expected from each contractor in fiscal year 2018
Detail design in fiscal year 2018 to increase design knowledge prior to contract award	Detail design begins in late fiscal year 2018 after downselect award

Source: GAO analysis of Navy documentation. | GAO-17-323

A consequence of the Navy’s accelerated frigate schedule is increased risk to the government because it refigures a commitment to buy ships in advance of adequate knowledge—a continuation of premature commitments by the LCS program.

Limited Detail Design Knowledge Available to Inform Frigate Award Decision Increases Risk of Cost and Schedule Growth as Design Matures

The Navy plans to award frigate construction to one shipyard before detail design activities specific to the frigate begin, which—as we previously have found—can result in increased ship prices and reduced understanding of how design changes will affect ship construction costs.¹² Detail design enables the shipbuilders to visualize spaces and test the design as the granularity of the design for individual units, or zones, of the ship comes into focus. The Navy had plans in 2015 to have each LCS shipyard conduct frigate detail design activities in fiscal year 2018. This improved understanding of the frigate design was then going to be available to support the Navy’s construction contracts to both shipyards for frigates in fiscal year 2019. However, as we noted above, the Navy changed course in response to direction from the Secretary of Defense and currently plans for a downselect award in 2018. The reduced contract award timeline led the Navy to abandon its plans to conduct detail design activities before contract award; the current plan is to begin detail design after the frigate downselect award and complete design activities before beginning construction.

¹²GAO-16-356, *Arleigh Burke Destroyers: Delaying Procurement of DDG 51 Flight III Ships Would Allow Time to Increase Design Knowledge*, GAO-16-613 (Washington, D.C.: Aug. 4, 2016), and *Defense Acquisitions: Improved Management Practices Could Help Minimize Cost Growth in Navy Shipbuilding Programs*, GAO-05-183 (Washington, D.C.: Feb. 28, 2005).

The Navy has noted that LCS's design is already complete and many areas of the frigate will be common to LCS—greater than 60 percent according to the frigate program office. However, with no detail design activities specific to the frigate upgrades planned until after the frigate shipbuilder is chosen by the Navy, the procurement activities—including shipbuilder proposal development, the Navy's completion of a construction cost estimate, and finalization of the target cost for constructing the lead frigate—will not be informed by a more complete understanding of the frigate-specific design. Our work on best practices for program cost estimates has found that over time, cost estimates become more certain as a program progresses—as costs are better understood and program risks identified.¹³ Further, we found in August 2016 that even Navy shipbuilders acknowledged the benefits of having detail design knowledge available to inform decisions.¹⁴ Specifically, the two shipbuilders for the Navy's newest configuration of the Arleigh Burke class destroyers—DDG 51 Flight III—agreed that allowing more time for the design to mature, via detail design, would provide greater confidence in their understanding of the Flight III-specific design changes and how the changes will affect ship construction costs. By completing more detail design activities prior to procuring a ship, the Navy—and shipbuilders—are better positioned for procurement and construction.

We also found in June 2016 and February 2005 that awarding a contract before detail design is completed—though common in Navy ship acquisitions—has resulted in increased ship prices.¹⁵ For example, the Navy negotiated target prices for construction of the lead San Antonio class ship (LPD 17) and the first two follow-on ships (LPD 18 and LPD 19) before detail design even began, preventing the Navy from leveraging information that would be gained during detail design when negotiating target prices for these three ships. In contrast, the Navy's Virginia class and Columbia class submarine programs had or planned to have a high level of design complete prior to the award of the lead ship construction contract, thus enabling the government to benefit from the knowledge gained from detail design in negotiating prices for construction.

¹³GAO, *GAO Cost Estimating and Assessment Guide*, [GAO-09-3SP](#) (Washington, D.C.: March 2, 2009).

¹⁴[GAO-16-613](#).

¹⁵[GAO-16-356](#) and [GAO-05-183](#).

Along with a shift away from detail design activities prior to the frigate award and a shortened time frame before the award, the Navy moved away from its planned government-driven design process to a less prescriptive contractor-driven design process, adding potential risk. This approach is similar to what the Navy used for the original LCS program, whereby the shipyards were given performance specifications and requirements and systems that would be provided by the government, but then selected the design and systems that they determined were best suited to fit their designs in a producible manner. Program officials told us that this new approach should yield efficiencies; however, history from LCS raises concern that this approach for the frigate similarly could lead to the ships having some non-standard equipment, with less commonality with LCS and the rest of the Navy's ships.

Significant LCS Testing Remains to Demonstrate Operational Capability Relevant to the Frigate

In addition to the prevailing cost and design unknowns that pose risk to the Navy's accelerated frigate acquisition plans, uncertainties remain regarding the operational capabilities of LCS that are relevant to the frigate. Some testing of operational capability already has been performed for LCS seaframes and the surface warfare mission package; however, the Navy does not plan to demonstrate operational capability in initial operational test and evaluation for the final surface warfare mission package until 2018 or demonstrate operational capability through initial operational test and evaluation for the anti-submarine warfare mission package until 2019. Additionally, the Navy has not demonstrated that LCS will achieve its survivability requirements—the LCS program office is planning for the final survivability assessment report to be completed in fiscal year 2018.

While preliminary results from full ship shock trials in 2016—live fire testing of the survivability of LCS and its subsystems against underwater shocks (i.e., explosions)—suggest some positive findings, DOT&E continues to have questions about LCS's survivability against more significant underwater shocks. Comprehensive reporting on the results of shock testing is not expected until later in 2017, which should provide a better understanding of any issues with the seaframes' response to underwater shock that have implications for the frigate design.

In addition to shock trials, both LCS variants sustained some damage in trials completed in rough sea conditions. Although the Navy indicated that the results of these trials have been incorporated into the structural design of both prospective frigate variants, the Navy has not completed its analytical reports of these events. Results from air defense testing also

indicate capability concerns, and both seaframe variants were found to have significant reliability and maintainability issues during several tests and trials. Further, DOT&E has expressed concern that LCS effectiveness with its mission packages remains undemonstrated, which means questions persist about the LCS's ability to perform many of its missions. These unknowns, in turn, will be carried over to the frigate program until the mission package capabilities that will also be employed by the frigate are fully demonstrated on the LCS.

The Navy's Planned Block Buy Approach Requires Early Commitment and Could Reduce Flexibility

DOD has made some progress with the frigate acquisition approach over the last year that is consistent with a recommendation we made in June 2016.¹⁶ Specifically, we recommended that the Secretary of Defense require that before a downselect decision is made for the frigate, the program must submit appropriate milestone documentation, such as an independent cost estimate and a plan to incorporate the frigate into DOD's Selected Acquisition Reports that are provided to Congress. The frigate's requirements have been finalized, with Joint Requirements Oversight Council approval received for its capabilities development document in 2016, and the Navy is in the process of establishing a service cost position. DOD's Office of Cost Assessment and Program Evaluation also plans to complete an independent cost estimate in fiscal year 2018.

Still, if current acquisition plans hold, the Navy will ask Congress to consider authorizing what the Navy calls a block buy of 12 frigates and funding the lead frigate when the fiscal year 2018 budget is proposed. This authorization decision involves potential future commitments of about \$9 billion based on early budget estimates. As indicated in table 4, the Navy's request for authority from Congress appears premature, since significant uncertainties will remain for the cost and design changes needed to turn an LCS into a frigate, and relevant questions regarding LCS operational capability will remain unresolved. For example, under the Navy's current plans, no formal cost estimate is expected to be completed before Congress is asked to make such a decision. Our prior work on best practices in weapon system acquisition has emphasized the

¹⁶[GAO-16-356](#).

importance of attaining key knowledge regarding cost, design, and capability expectations before making major commitments.¹⁷

Table 4: Assessment of Information Deficiencies in 2017 Indicating That Planned Request for Congressional Decisions on Frigate Acquisition Is Premature

Key information	Description	GAO assessment of information available in April 2017
Realistic cost estimates	Navy service cost position is expected in May 2017; Office of the Secretary of Defense plans to complete an independent cost estimate in fiscal year 2018.	○
Well-defined design	Approval of build specifications is planned for July 2017; frigate-specific detail design will not begin until after construction award in summer 2018, with completion by the end of 2019.	○
Littoral combat ship (LCS) operational capability	Some testing of operational capability has been performed for LCS seaframes and surface warfare mission package. However, initial operational test and evaluation of seaframes and the final surface warfare mission package is not planned to begin until 2018, and initial operational test and evaluation of seaframes and the anti-submarine warfare mission package is not planned to begin until 2019. Also, the LCS program office does not expect the final survivability assessment report to be completed until fiscal year 2018.	●

Legend: ○ Information not available ● Some information available

Source: GAO analysis of Department of Defense documentation. | GAO-17-323

While a block buy contracting approach may provide cost savings and other benefits for an acquisition program, it also may present challenges, such as reduced funding flexibility.¹⁸ For example, the LCS block buy contracts provide that a failure to fully fund the purchase of a ship in a given year would make the contract subject to renegotiation. DOD has pointed to this as a risk that the contractors would demand higher prices if DOD deviated from the agreed to block buy plan. Thus, once the frigate block buy contract is authorized and funded, DOD and Congress may once again have a notable disincentive to take any action that might delay procurement. This has been the case with LCS, even when it became apparent that the program was underperforming.

¹⁷GAO, *Best Practices: Capturing Design and Manufacturing Knowledge Early Improves Acquisition Outcomes*, [GAO-02-701](#) (Washington, D.C.: July 15, 2002) and *Defense Acquisitions: Assessments of Selected Weapon Programs*, [GAO-16-329SP](#) (Washington, D.C.: March 31, 2016).

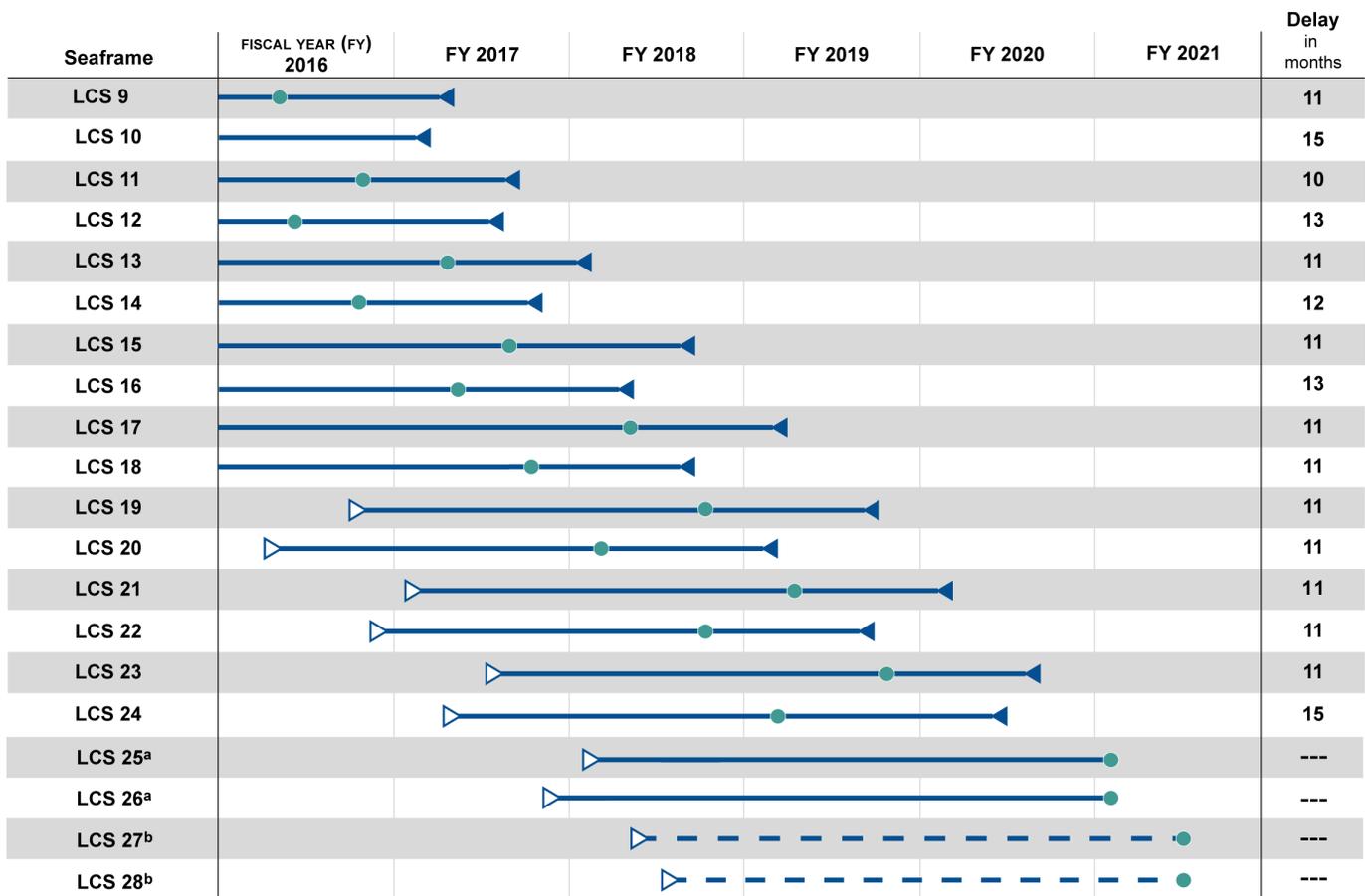
¹⁸GAO, *F-35 Joint Strike Fighter: Continued Oversight Needed as Program Plans to Begin Development of New Capabilities*, [GAO-16-390](#) (Washington, D.C.: April 14, 2016).

**Existing and Planned
Shipyard Construction
Workloads for LCS
Suggest No Schedule
Imperative to Begin
Frigate Acquisition in 2018**

The existing and planned LCS construction workloads at both shipyards suggest that a request in 2017 to authorize the frigate (with the fiscal year 2018 budget request) may not only be premature, but also unnecessary. Although the Navy has argued that pausing LCS production would result in loss of production work and start-up delays to the frigate program, current schedule delays for LCS under construction and the projected schedules for the yet-to-be-awarded LCS show that both shipyards have substantial workloads remaining that could offset the need to award the frigate in 2018 as planned. The Navy's concern about shipyard workload also does not account for the possibility of continued delays in the delivery of LCS.

Deliveries of almost all LCS under contract at both shipyards (LCS 5-26) have been delayed by several months, and, in some cases, close to a year or longer. Despite having had 5 years of LCS construction to help stabilize ship delivery expectations, the program did not deliver four LCS in fiscal year 2016 as planned. As figure 3 depicts, delays that have occurred for previously funded ships have resulted in a construction workload that extends into fiscal year 2020. This prolonged workload, when combined with the two LCS awarded in 2016 and two more LCS that have been authorized by congressional conferees and the Navy plans to award in fiscal year 2017, takes construction at both shipyards into 2021.

Figure 3: Construction Demands for Littoral Combat Ship (LCS) Shipyards



Legend

- ▶ Current start construction date
- Original delivery date
- ▶ Modified delivery date
- - - Planned schedule

LCS = Littoral Combat Ship

Source: GAO analysis of Navy contract data and budget documents. | GAO-17-323

^aThe delivery dates for LCS 25 and 26—awarded in March 2016—have not been modified.

^bThe Navy has not awarded contracts for construction of LCS 27 or 28, so start and delivery dates represent current plans.

With 13 LCS in various phases of construction (LCS 9, 11-22) and 3 more (LCS 23, 24, and 26) set to begin construction later in fiscal year 2017, delaying a decision on the frigate until fiscal year 2019 would enable the

Navy and the shipbuilders to improve knowledge on cost, design, and operational capability of LCS that relates directly to the frigate. This, in turn, would offer Congress an opportunity to be better informed on the expectations for the frigate before committing substantial taxpayer funds to this program.

Conclusions

The Navy's impending fiscal year 2018 budget request presents a key opportunity for Congress to affect the way forward for the frigate program by ensuring the Navy possesses sufficient knowledge on cost, design, and capability before authorizing an investment of a potential \$9 billion for a program that

- has no current formal cost estimate—-independent or otherwise,
- will not have begun key detail design activities,
- has significant unknowns in regards to operational performance of the ship upon which it will be based, and
- based on the existing and planned shipyard workloads, has no industrial base imperative to begin construction in the Navy's planned time frame.

The block buy pricing the Navy expects to receive from LCS contractors in 2017 will be for the basic LCS seaframes that the Navy has acknowledged do not meet its needs. As we stated above, the two LCS shipbuilders—when faced with the prospect of a downselect in 2010—provided competitive pricing that propelled the Navy to continue production at both shipyards. Those prices have not been shown to be achievable. Even if LCS prices offered once again appear favorable, the ships ultimately are intended to be frigates, and the upgrade cost—to be proposed by the shipyards later—is a significant unknown.

A decision by Congress to authorize the block buy of 12 frigates is effectively the final decision for the entire planned buy of 40 LCS and frigates. According to the Navy's approved acquisition strategy, the frigates would still require annual appropriations and Congress could thus conduct oversight of the program through that process; however, it will likely be more difficult to make decisions to reduce or delay the program should that become warranted, as the Navy may point to losses in favorable block buy prices, as has been done previously with LCS.

We recognize that the Navy had to revise its frigate acquisition plans based on the Secretary of Defense's direction to reduce quantities and

select a single ship design. However, the direction did not necessitate an acceleration of the frigate procurement and the corresponding shift away from a planned approach that would have provided substantially improved cost, design, and capability information to inform the frigate acquisition decisions. Reverting back to a frigate award in fiscal year 2019 would provide time to complete realistic cost estimates, build detail design knowledge, and make significant progress in understanding the operational capability and limitations of LCS, upon which the frigate design will be based.

Matter for Congressional Consideration

To ensure sound frigate procurement decisions, Congress should consider not enacting authority pursuant to the Navy's request for a block buy of 12 frigates in the fiscal year 2018 budget and consider delaying funding of the lead frigate until at least fiscal year 2019 when sufficient cost, design, and capability knowledge is expected to be available to inform decisions.

Recommendation for Executive Action

To ensure the department and the shipbuilders have sufficient knowledge of the frigate's anticipated cost and design during the procurement process, the Secretary of Defense should direct the Secretary of the Navy to delay frigate procurement plans and the award of the lead frigate contract until at least fiscal year 2019 when cost estimates will be completed, detail design could be underway, and significant progress will have been made in demonstrating through testing the operational capabilities of LCS that are relevant to the frigate.

Agency Comments and Our Evaluation

We provided a draft of this report to DOD for review and comment. Its written comments are reprinted in appendix I of this report. DOD partially concurred with our recommendation to delay procurement plans and the award of the lead frigate contract until sufficient cost, design, and capability knowledge is available to inform decisions.

In its response, DOD acknowledged that the Navy's final contract decision includes risks, but stated that it believes the current plan offers an acceptable tradeoff between technical and affordability risks. DOD highlighted two actions that it believes will allow the department to assess program risk before moving forward: (1) annual frigate program review activities in 2017 intended to ensure risks are understood prior to the release of the formal frigate request for proposals, and (2) the planned completion of an independent cost estimate in fiscal year 2018 by the

Office of Cost Assessment and Program Evaluation, which is expected to inform a 2018 annual program review prior to a contract award.

While these are positive oversight actions, the assessments of design risk and maturity for these reviews will lack any frigate-specific detail design information, which leads us to maintain that waiting until at least fiscal year 2019 to procure the first ship and to make decisions on future frigate procurements would provide DOD and Congressional decision-makers with a more comprehensive understanding of frigate cost, design, and capability expectations before making substantial commitments to the program. This lack of knowledge, coupled with the ongoing and planned LCS construction workload at both shipyards, present, in our view, a compelling rationale for delaying a frigate decision.

DOD also separately provided technical comments on our draft report. We incorporated the comments as appropriate, such as to provide additional context in the report. In doing so, we found that the findings and message of our report remained the same. In some cases, the department's suggestions or deletions were not supported by the preponderance of evidence or were based on a difference of opinion, rather than fact. In those instances, we did not make the suggested changes.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense, the Secretary of the Navy, and other interested parties. In addition, this report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-4841 or mackinm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix IV.



Michele Mackin
Managing Director, Acquisition and Sourcing Management

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Committee on Appropriations
House of Representatives

Appendix I: Comments from the Department of Defense



OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3015 DEFENSE PENTAGON
WASHINGTON, DC 20301-3015

MAR 31 2017

Ms. Michele Mackin
Director
Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Ms. Mackin:

This letter serves as the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GAO-17-323, "LITTORAL COMBAT SHIP AND FRIGATE: Delaying Planned Frigate Acquisition Would Enable Better-Informed Decisions," dated February 21, 2017 (GAO Code 101078).

The Department acknowledges receipt of the draft report. As more fully explained in the enclosure, the Department partially concurs with the report's only recommendation.

The Department appreciates the opportunity to comment on the draft report. For further questions concerning this report, please contact Dr. James D. Moreland, Jr., Deputy Director for Naval Warfare, at james.d.moreland18.civ@mail.mil or 703-614-3170.

Sincerely,

Dyke D. Weatherington
Performing the Duties of the
Assistant Secretary of Defense
for Acquisition

Enclosure:
As stated

GAO DRAFT REPORT DATED FEBRUARY 21, 2017
GAO-17-323 (GAO CODE 101078)

“LITTORAL COMBAT SHIP AND FRIGATE: DELAYING
PLANNED FRIGATE ACQUISITION WOULD ENABLE
BETTER-INFORMED DECISIONS”

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION

RECOMMENDATION: To ensure the department and the shipbuilders have sufficient knowledge of the Frigate’s anticipated cost and design during the procurement process, the Secretary of Defense should direct the Secretary of the Navy to delay Frigate procurement plans and the award of the lead Frigate contract until at least fiscal year 2019 when cost estimates will be completed, detail design will be underway, and sufficient progress will have been made in establishing the operational capabilities of LCS that are relevant to the Frigate.

DoD RESPONSE: Partially Concur. The Department recognizes that a final contract decision for the Frigate in fiscal year (FY) 2018 does include some risks; however, as outlined in Revision 3 of the LCS Acquisition Strategy signed by the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) on March 29, 2016, the Navy’s approach offers an acceptable tradeoff between technical and affordability risks to proceed. Future USD(AT&L)-led reviews will revisit the risks before making key programmatic decisions.

During the 2016 annual LCS/Frigate program review chaired by USD(AT&L) on April 27, 2016, the program’s transition from the current LCS design to the Frigate was a key discussion area. There were two actions assigned at the 2016 annual program review to directly address the anticipated risks of shifting to the Frigate design in FY 2018 described below.

First, the Navy will return for the 2017 annual LCS/Frigate program review in advance of the planned release of the formal Frigate request for proposals (RFP) to the two current LCS shipyards. The annual review will also include a review of the planned Frigate technologies and assess the risks not only of the individual combat systems to be incorporated but also assess the integration risks of bringing these systems to the Frigate. USD(AT&L) will ensure the Navy updates the affordability analysis done in accordance with DoDI 5000.02 before releasing the RFP. The Navy will work closely with DoD’s Office of Cost Assessment and Program Evaluation (CAPE) to gain CAPE’s review of their service cost position to ensure that affordability risks are understood before the RFP is released.

Second, CAPE will complete an Independent Cost Estimate (ICE) in FY 2018 in response to the Frigate RFP released later this year. The 2018 annual LCS/Frigate program review will occur in advance of the planned Frigate contract award and will be

ENCLOSURE

informed by the CAPE ICE to address cost and affordability risks and how to best proceed. This review will also address the status of the Frigate design, new capability risks, and integration risks.

Further, before release of the FY 2017 Frigate RFP, the Navy plans to complete an independent design review to ensure the Frigate construction contract designs have reached a sufficient level of maturity. The Navy will include key stakeholders, including OUSD(AT&L), in the design review to determine the levels of maturity reached with each of the designs being considered and will then decide, using entrance and exit criteria, the timing for release of the formal Frigate RFP.

The Department's goal is to ensure that all program cost and design risks are identified and assessed before making a determination on how the Frigate program should proceed in FY 2018. The Secretary of Defense (SECDEF) guidance to the Navy on December 14, 2015, directed the down-select to one LCS/Frigate variant in FY 2019 but does not ignore the potential for accelerating the down-select decision to be earlier. Since the release of the guidance, SECDEF has continued to assess options for an earlier Frigate decision and the Navy's current plan/strategy supports that. There are noted risks and there are planned reviews in FY 2017 and FY 2018 to assess the health and risk of the program before major programmatic decisions are made.

ENCLOSURE

Appendix II: Selected GAO Recommendations for the Littoral Combat Ship and Frigate Programs

Table 5: Selected GAO Recommendations for Littoral Combat Ship (LCS) and Frigate Programs and Department of Defense (DOD) Responses, 2005-2016

Year	GAO Recommendation	DOD Response
2005	<ul style="list-style-type: none"> Revise LCS acquisition strategy to ensure that the Navy has sufficiently experimented with both ship designs, captured lessons learned, and mitigated operational and technology risks before award of a detail design and construction contract. 	<ul style="list-style-type: none"> DOD partially agreed with this recommendation, stating that it would review the acquisition strategy before award of contracts for additional ships. DOD noted, however, that the LCS program entailed risk by design, and that DOD seeks to balance the program's acquisition risks with the risk of delaying closure of the warfighting gaps that LCS will fill.
2010	<ul style="list-style-type: none"> Update the LCS acquisition strategy to account for operational testing delays in the program and re-sequence planned purchases of ships and mission packages, as appropriate. 	<ul style="list-style-type: none"> DOD agreed with this recommendation; however, the Navy subsequently altered its acquisition strategy significantly, resulting in the award of block buy contracts in 2010 without demonstrating knowledge related to, among other things, operational testing of at least one of the mission packages on each variant.
2013	<ul style="list-style-type: none"> Procure the minimum quantity and rate of ships required to preserve the mobilization of the production base until the successful completion of the full-rate production decision review. Report to Congress on the relative advantages of each seaframe variant for each of the three mission areas. 	<ul style="list-style-type: none"> DOD did not agree with our recommendation regarding the quantity and rate of ships to be purchased, stating that it would unnecessarily decrease production and result in higher pricing for individual seaframes with no value added to the program. DOD agreed with this recommendation, and Congress directed the Navy to provide additional information on some of the risk areas we identified, but the Navy essentially suggested that since the two variants are built to the same requirements, they perform the same way.
2014	<ul style="list-style-type: none"> Before approving the release of the request for proposals for future contracts for either seaframe variant, require both variants to, among other things, deploy to a forward overseas location and complete rough water, ship shock, and total ship survivability testing. 	<ul style="list-style-type: none"> DOD partially agreed with this recommendation, stating its intention to complete as many of the tests and demonstrations as possible before releasing the request for proposals. The department, however, maintained that the release of the request for proposals should not hinge on these actions.
2015	<ul style="list-style-type: none"> Ensure that the Navy's acquisition strategy for the modified LCS does not place industrial base concerns ahead of demonstrating the ship's lethality, survivability, and affordability. 	<ul style="list-style-type: none"> DOD agreed with this recommendation, stating that the Secretary will ensure that industrial base concerns are balanced against cost, schedule, and fleet requirements. In March 2016, however, the department approved the Navy's strategy to acquire an LCS with minor modifications, or frigate—a ship concept it had previously recommended to the department based in large part on industrial base considerations.
2016	<ul style="list-style-type: none"> Before a downselect decision for the frigate, require the program to submit milestone documentation, which could include an independent cost estimate, an acquisition program baseline, and a plan to incorporate the frigate into DOD's Selected Acquisition Reports to Congress. 	<ul style="list-style-type: none"> DOD partially agreed, stating that the Navy views the LCS transition to the frigate as an incremental upgrade. DOD stated that the program would be required to provide key documentation, including an independent cost estimate and an updated acquisition program baseline. The response did not address our concerns about transparency in the Selected Acquisition Reports.

Source: GAO analysis of prior GAO reports and DOD actions taken or planned. | GAO-17-323

Appendix III: Related GAO Products

Littoral Combat Ship and Frigate: Slowing Planned Frigate Acquisition Would Enable Better-Informed Decisions. [GAO-17-279T](#). Washington, D.C.: December 8, 2016.

Littoral Combat Ship and Frigate: Congress Faced with Critical Acquisition Decisions. [GAO-17-262T](#). Washington, D.C.: December 1, 2016.

Littoral Combat Ship: Need to Address Fundamental Weaknesses in LCS and Frigate Acquisition Strategies. [GAO-16-356](#). Washington, D.C.: June 9, 2016.

Littoral Combat Ship: Knowledge of Survivability and Lethality Capabilities Needed Prior to Making Major Funding Decisions. [GAO-16-201](#). Washington, D.C.: December 18, 2015.

Littoral Combat Ship: Navy Complied with Regulations in Accepting Two Lead Ships, but Quality Problems Persisted after Delivery. [GAO-14-827](#). Washington, D.C.: September 25, 2014.

Littoral Combat Ship: Additional Testing and Improved Weight Management Needed Prior to Further Investments. [GAO-14-749](#). Washington, D.C.: July 30, 2014.

Littoral Combat Ship: Deployment of USS Freedom Revealed Risks in Implementing Operational Concepts and Uncertain Costs. [GAO-14-447](#). Washington, D.C.: July 8, 2014.

Navy Shipbuilding: Opportunities Exist to Improve Practices Affecting Quality. [GAO-14-122](#). Washington, D.C.: November 19, 2013.

Navy Shipbuilding: Significant Investments in the Littoral Combat Ship Continue Amid Substantial Unknowns about Capabilities, Use, and Cost. [GAO-13-738T](#). Washington, D.C.: July 25, 2013.

Navy Shipbuilding: Significant Investments in the Littoral Combat Ship Continue Amid Substantial Unknowns about Capabilities, Use, and Cost. [GAO-13-530](#). Washington, D.C.: July 22, 2013.

Defense Acquisitions: Realizing Savings under Different Littoral Combat Ship Acquisition Strategies Depends on Successful Management of Risks. [GAO-11-277T](#). Washington, D.C.: December 14, 2010.

National Defense: Navy's Proposed Dual Award Acquisition Strategy for the Littoral Combat Ship Program. [GAO-11-249R](#). Washington, D.C.: December 8, 2010.

Defense Acquisitions: Navy's Ability to Overcome Challenges Facing the Littoral Combat Ship Will Determine Eventual Capabilities. [GAO-10-523](#). Washington, D.C.: August 31, 2010.

Littoral Combat Ship: Actions Needed to Improve Operating Cost Estimates and Mitigate Risks in Implementing New Concepts. [GAO-10-257](#). Washington, D.C.: February 2, 2010.

Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding. [GAO-09-322](#). Washington, D.C.: May 13, 2009.

Defense Acquisitions: Overcoming Challenges Key to Capitalizing on Mine Countermeasures Capabilities. [GAO-08-13](#). Washington, D.C.: October 12, 2007.

Defense Acquisitions: Plans Need to Allow Enough Time to Demonstrate Capability of First Littoral Combat Ships. [GAO-05-255](#). Washington, D.C.: March 1, 2005.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Michele Mackin at (202) 512-4841 or mackinm@gao.gov.

Staff Acknowledgments

In addition to the contact above, Diana Moldafsky, Assistant Director; Pete Anderson; Jacob Leon Beier; Laurier Fish; Kristine Hassinger; C. James Madar; Sean Merrill; LeAnna Parkey; Anne Stevens; and Robin Wilson made key contributions to this report.

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