United States Government Accountability Office

Report to the Committee on Armed Services, House of Representatives

May 2024

NAVY FRIGATE

Unstable Design Has Stalled Construction and Compromised Delivery Schedules

GAO-24-106546

GAO Highlights

Highlights of GAO-24-106546, a report to the Committee on Armed Services, House of Representatives

May 2024

NAVY FRIGATE

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Why GAO Did This Study

In 2017, the Navy began the frigate program in response to the shortcomings of the Littoral Combat Ship and evolving threats. Construction began on the first ship, FFG 62, in August 2022.

A House report includes a provision for GAO to examine the frigate program. GAO's review assesses (1) progress made in frigate design and construction within planned cost and schedule; (2) technical uncertainties to planned frigate capabilities and any plans to resolve them; and (3) opportunities to incorporate leading practices for product development within the frigate program.

GAO reviewed program documents, interviewed Navy and contractor officials, and compared the frigate program to leading practices for product development.

What GAO Recommends

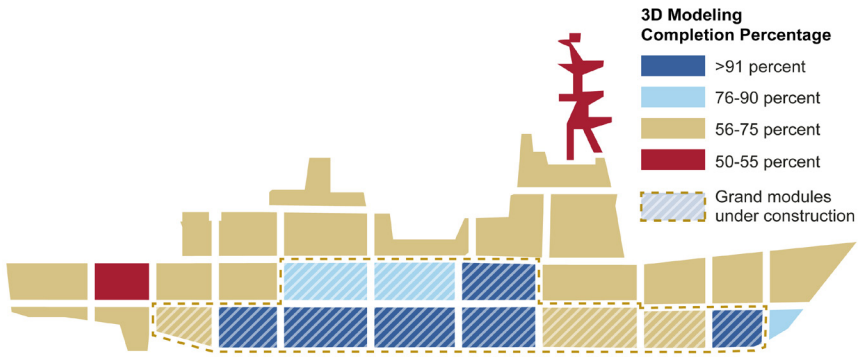
GAO is making five recommendations, including that the Navy restructure its design stability metric to measure progress based more on the quality than quantity of design documents; use the improved metric to assess the design stability before beginning construction of the second frigate; incorporate additional land-based testing into the frigate test plan; and identify opportunities to further incorporate leading practices for product development into the frigate acquisition strategy. The Navy agreed with four recommendations and partially agreed with the recommendation related to updating the test plan. GAO maintains that all five recommendations should be fully implemented.

View GAO-24-106546. For more information, contact Shelby S. Oakley at (202) 512-4841 or OakleyS@gao.gov.

What GAO Found

Over at least 2 decades, the Navy's *Constellation* class Guided Missile Frigate program plans to acquire and deliver up to 20 frigates—multi-mission, small surface combatant warships—at a combined cost of over $22 billion. To reduce technical risk, the Navy and its shipbuilder modified an existing design to incorporate Navy specifications and weapon systems. However, the Navy's decision to begin construction before the design was complete is inconsistent with leading ship design practices and jeopardized this approach. Further, design instability has caused weight growth. The figure shows the frigate's 3D design—a component of design stability—as incomplete over 1 year after construction began.

Lead Frigate 3D Modeling Progress by Grand Module, as of October 2023



Source: GAO (analysis); Navy (image and data). | GAO-24-106546

Delays in completing the ship design have created mounting construction delays. The Navy acknowledges that the April 2026 delivery date, set in the contract at award, is unachievable. The lead frigate is forecasted to be delivered 36 months later than initially planned. The program office tracks and reports design progress, but its design stability metric hinges largely on the quantity—rather than quality—of completed design documents. This limits insight into whether the program's schedule is achievable. If the Navy begins construction on the second frigate without improving this metric, it risks repeating the same errors that resulted in construction disruptions and delays with the lead frigate.

The frigate is using many mission systems already proven on Navy ships. However, the Navy has yet to demonstrate two systems—the propulsion and machinery control systems. A planned update to the frigate test plan—combined with the opportunity afforded by schedule delays—could offer the Navy the chance to conduct land-based testing of these two unproven systems. This testing would reduce the risk of discovering issues after the ship is at sea.

The frigate is using a traditional, linear development approach for design and construction. The Navy has historically experienced schedule delays, cost growth, or both in prior shipbuilding programs using this approach. The Navy has incorporated elements of leading practices into its acquisition strategy. However, further incorporating these practices in an updated acquisition strategy could position the program, when contracting for future frigates, to better respond to evolving mission needs.

Contents

Abbreviations

CAPTAS-4C	Combined Active Passive Towed Array
CDRL	Contract Data Requirements List
DOD	Department of Defense
DOT&E	Director of Operational Testing and Evaluation
FMM	Fincantieri Marinette Marine
LBES	Land Based Engineering Site
LCS	Littoral Combat Ship
MCA	Major Capability Acquisition
NAVSEA	Naval Sea Systems Command
RFP	request for proposal
TEMP	Test and Evaluation Master Plan
VLS	Vertical Launch System

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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May 29, 2024

The Honorable Mike Rogers
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

Over at least 2 decades, the Navy's *Constellation* class Guided Missile Frigate program plans to acquire and deliver up to 20 multi-mission, small surface combatant warships at a combined cost of over $22 billion. The Navy requires that these frigates be more lethal and survivable than their predecessor, the Littoral Combat Ship (LCS), which the Navy and Congress truncated acquisition of following years of performance shortfalls, deficiencies, and cost growth. The poor acquisition outcomes of LCS, coupled with evolving threats and persisting fleet needs for small surface combatant warships, prompted the Navy to accelerate delivery of frigates by minimizing technology development and streamlining the frigate acquisition approach.

As we previously reported, the Navy competitively awarded frigate conceptual design contracts valued at nearly $15 million each to five industry teams in February 2018.[1] These 16-month contracts were intended to enable industry to mature parent ship designs—designs for the frigate that are based on existing ships demonstrated at sea—and help refine technical and operational program requirements. We also found that the Navy requested funding for the lead frigate before it had validated its cost expectations.[2] In April 2020, the Navy awarded a contract to Fincantieri Marinette Marine (FMM) for detail design and

[1]GAO, *Guided Missile Frigate, Navy Has Taken Steps to Reduce Acquisition Risk, but Opportunities Exist to Improve Knowledge for Decision Makers*, GAO-19-512 (Washington, D.C.: Aug. 9, 2019).

[2]GAO-19-512. We recommended that the Navy provide Congress with the independent cost estimate for the frigate program prior to the detail design and construction contract award. The Department of Defense (DOD) concurred with this recommendation, stating that the frigate program would ensure it provides Congress with certified cost estimate information prior to award of the detail design and construction contract. In April 2020, DOD's Office of Cost Assessment and Program Evaluation completed the independent cost estimate for the frigate program. Consistent with our recommendation, the Navy communicated this updated cost information to Congress prior to the award of the detail design and construction contract on April 30, 2020.

construction of the lead frigate (FFG 62) with options for construction of up to nine additional ships. As of March 2024, the Navy has exercised three of these options (FFG 63, FFG 64, and FFG 65).

Since beginning construction on the lead frigate in August 2022, the program has faced design and construction challenges. As a result of these challenges, the shipbuilder now forecasts delivering the lead ship in 2029—approximately 36 months later than the April 2026 delivery date set in the contract at award. The program's acquisition strategy allows the option for a second shipbuilder in the future to build additional ships beyond the 10 currently under contract.

The House Report 117-397 accompanying a bill to the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 contains a provision for us to examine the frigate program.[3] Our review assesses (1) progress the Navy and its shipbuilder made in completing the frigate design and constructing ships within planned cost and schedule; (2) the extent to which there are technical uncertainties that pose risk to planned capabilities for frigates and the Navy's plans to resolve those uncertainties; and (3) future opportunities to incorporate leading practices for product development within the frigate program.

To assess design and construction progress, we assessed documentation related to design and construction efforts on the lead frigate. This includes design progress metrics, contract data requirements list (CDRL) items approval rates, program briefings, integrated master schedule reviews, and budget materials, among other documents. We compared the program's progress in design and construction to leading practices that we previously identified for design in commercial shipbuilding.[4]

To address technical uncertainties that pose risk to planned capabilities for frigates, we analyzed frigate budget materials and shipbuilder documents to identify costly and mission-critical developmental systems planned to provide key capabilities to the frigates. We then reviewed these systems' development schedules and program briefings and

[3]See H.R. Rep. No. 117-397, at 18.

[4]GAO, *Navy Shipbuilding: Increased Use of Leading Design Practices Could Improve Timeliness of Deliveries*, GAO-24-105503 (Washington, D.C.: May 2, 2024); and *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding,* GAO-09-322 (Washington, D.C.: May 13, 2009).

interviewed relevant officials to determine any technical uncertainties and associated risks. We also reviewed Navy documents to identify plans for resolving technical uncertainties prior to lead ship delivery.

To identify future opportunities to incorporate leading practices for product development within the frigate program, we reviewed the frigate's November 2022 acquisition strategy and compared it against leading practices for product development.[5] Specifically, we analyzed the extent to which the Navy (1) structured the frigate program to capitalize on the innovation and schedule advantages afforded through iterative development cycles and (2) incorporated other leading practices that propel these cycles, such as maintaining a sound business case, off-ramping capabilities that present a risk to schedule, collecting user feedback, and using iterative, agile methods centered on developing a minimum viable product.[6]

For each of our objectives, we interviewed relevant Navy officials and contractor representatives. This included interviewing frigate program officials to seek their input on an initial draft of our leading practices analysis of the frigate acquisition strategy. A more detailed description of our scope and methodology is presented in appendix I.

We conducted this performance audit from January 2023 to May 2024 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

Frigate Design Attributes

The Navy plans for new frigates to serve as multi-mission, small surface combatants capable of conducting air warfare, surface warfare, anti-submarine warfare, and electromagnetic warfare operations. The Navy expects frigates to operate in both blue water (i.e., mid-ocean) and littoral

[5]GAO, *Leading Practices: Iterative Cycles Enable Rapid Delivery of Complex, Innovative Products,* GAO-23-106222 (Washington, D.C.: July 27, 2023); and *Leading Practices: Agency Acquisition Policies Could Better Implement Key Product Development Principles,* GAO-22-104513 (Washington, D.C.: Mar. 10, 2022).

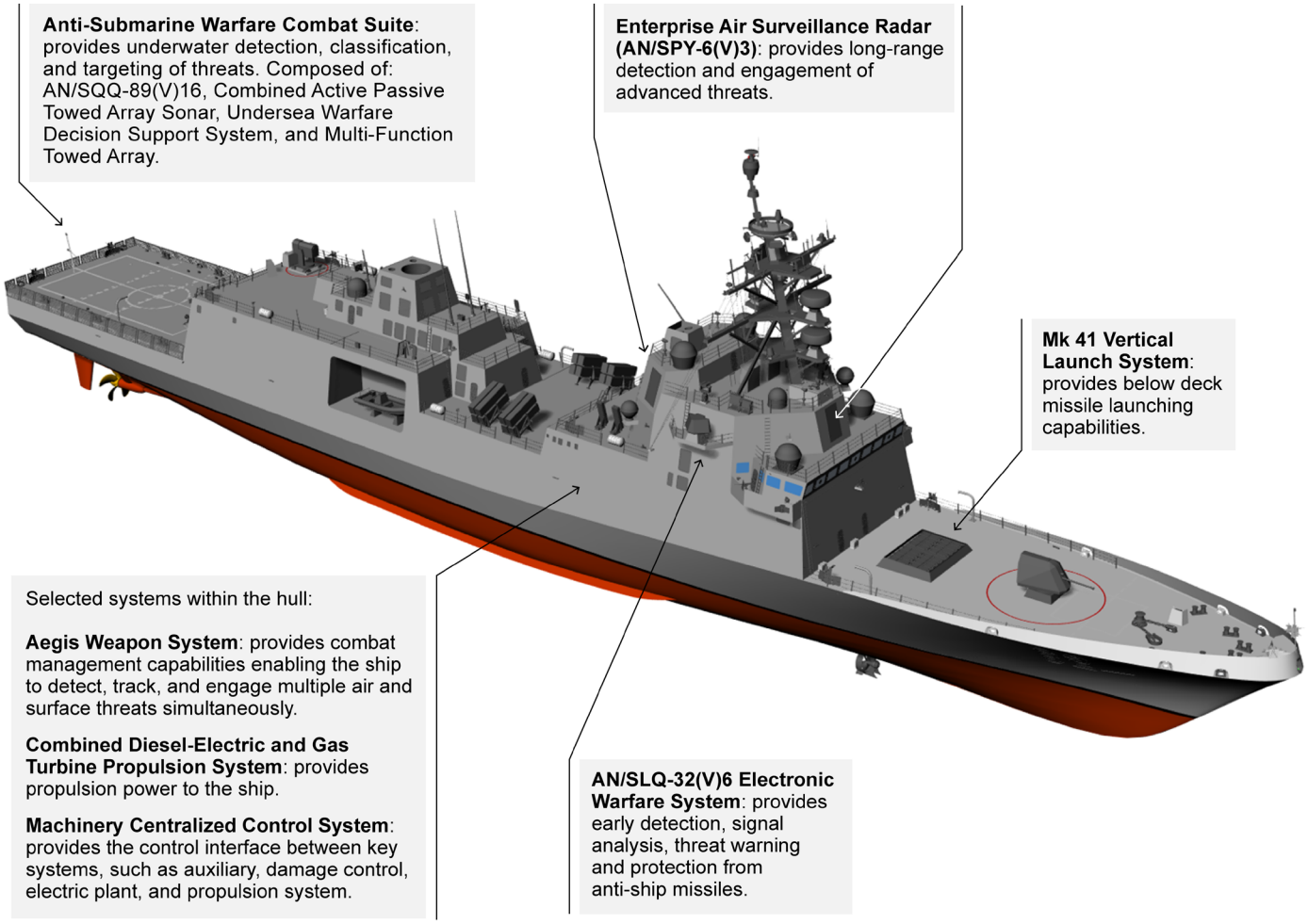
[6]A minimum viable product includes the initial set of capabilities needed to recognize value.

(i.e., near-shore) areas, either independently or as part of larger fleet formations. In 2014, the Secretary of Defense directed the Navy to evaluate alternatives to LCS, citing survivability and lethality concerns. In 2017, the Navy began the current frigate program. The Navy's approach to developing and acquiring frigates evolved and matured from 2014 through 2019—a process that we have described in several prior reports.[7]

To reduce technical risk, the parent ship design approach was intended to leverage and modify an existing hull design already demonstrated at sea. The frigate design also includes various systems that will enable the ship to perform its missions. The Navy adapted the parent design to accommodate these systems and meet Navy habitability and survivability requirements. Figures 1 and 2 depict selected mission systems on the frigate and design changes between the parent and Navy frigate designs.

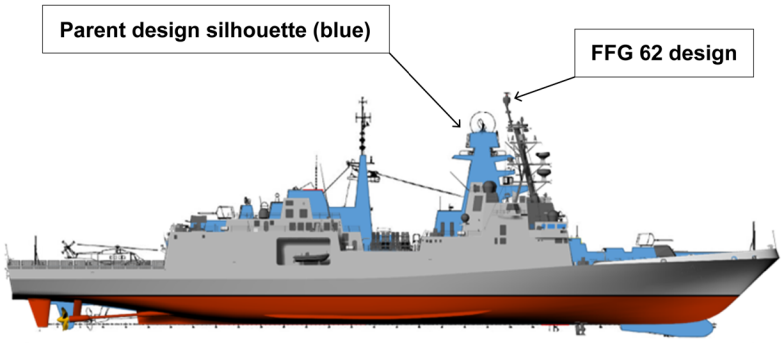
[7]GAO-19-512, *Littoral Combat Ship and Frigate: Delaying Planned Frigate Acquisition Would Enable Better-Informed Decisions,* GAO-17-323 (Washington, D.C.: Apr. 18, 2017); *Littoral Combat Ship and Frigate: Congress Faced with Critical Acquisition Decisions,* GAO-17-262T (Washington, D.C.: Dec. 1, 2016); and *Littoral Combat Ship: Need to Address Fundamental Weaknesses in LCS and Frigate Acquisition Strategies,* GAO-16-356 (Washington, D.C.: June 9, 2016).

Figure 1: Selected FFG 62 Mission Systems



Source: GAO (analysis); Navy (image and data). | GAO-24-106546

Figure 2: Illustration of FFG 62 Design Changes from Parent Design



- Hull lengthened 23.6 feet to accommodate larger generators and future growth.
- Bow design modified to remove sonar dome and enclosure deck for stability.
- Generator rating increased to support transit speed and future growth.
- Propeller changed for improved acoustic performance.
- Displacement increased by ~500 tons for margins and future growth.
- Topside modified to accommodate U.S. Navy warfare systems.

Source: Navy. | GAO-24-106546

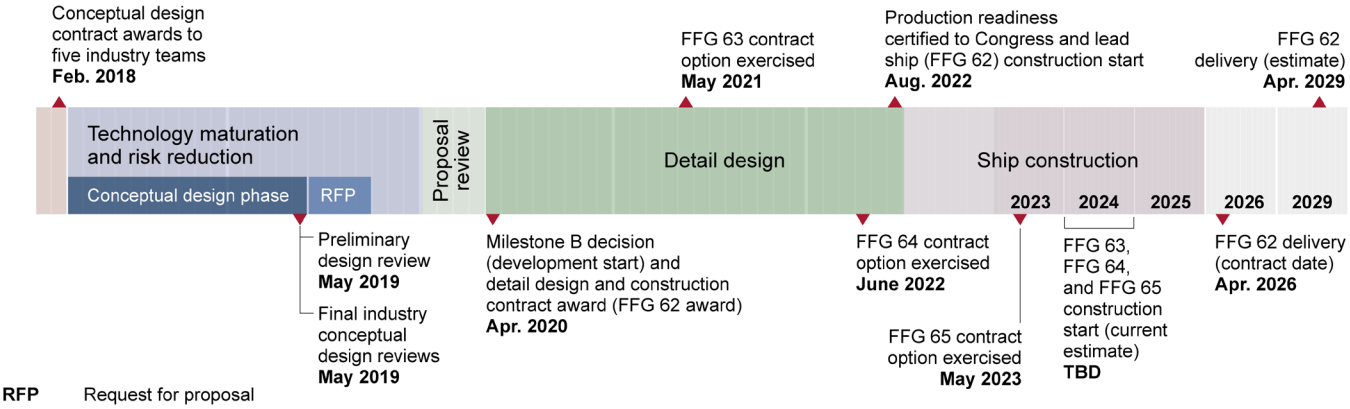
Note: The parent design silhouette in the figure above is based on the *Bergamini* class European Multi-Mission Frigate.

Frigate Schedule and Funding

In April 2020, the Navy awarded the detail design and construction contract for the frigate to FMM. Over two years later, in August 2022, the Secretary of Navy reported and certified to the congressional defense committees on the results of its production readiness review. The Secretary of Navy certified that the ship's basic and functional design were complete before approving construction on the program's first ship.[8] Figure 3 below catalogs key frigate program events dating back to 2018 as well as future plans.

[8]We previously reported that the Navy approach meets the statutory requirements in section 8669c(a), title 10, United States Code to certify completion of basic and functional design. However, the frigate certification and production readiness review reporting did not demonstrate the type of clear connection between design maturity data and decision-making on construction readiness expected by leading practices. As such, we made multiple matters for congressional consideration related to production readiness reviews. Further, the Navy used different factors and metrics to certify the frigate basic and functional design as complete as compared to leading ship design practices. In this report, when we state that the Navy's functional design is incomplete, we are assessing the Navy's design completion against these leading practices. See GAO-24-105503.

Figure 3: Frigate Acquisition Schedule



RFP Request for proposal

Source: GAO analysis of Navy information. | GAO-24-106546

Congress authorized and appropriated funding for the first six frigates at a rate of one to two per year between fiscal years 2020 and 2024. The Navy's fiscal year 2025 budget request identifies funding through fiscal year 2027 for the four additional frigates (one to two ships per year) that the Navy included under its detail design and construction contract.

Additionally, the Navy has identified nearly $310 million in cost growth on key government furnished equipment systems for the first four frigates. The Navy also identified cost growth for future frigates. Program officials stated that the cost growth is largely due to inflation and economic factors affecting material and labor prices. The Navy received nearly $310 million through a reprogramming action to address this cost growth.[9] It plans to request funds for identified cost growth in fiscal years 2025-2029 in budget requests for those years. Table 1 includes details on the Navy's fiscal year 2025 budget estimate for the frigate program.

[9]Funds were transferred pursuant to the Department of Defense Appropriations Act, 2023, Section 8121, which made funds available for transfer to reflect revised economic assumptions. Pub. L. No. 117-328, §8121 (2022).

Table 1: Navy's Fiscal Year 2025 Budget Estimate for *Constellation* Class Frigate Program

(Dollars in millions)

	Prior Years	2023	2024	2025	2026	2027	To complete
Ship quantities	3	1	2	1	2	1	10
Shipbuilding and Conversion funding	$3,431.2[a]	$1,444.8	$2,173.7	$1,170.4	$2,195.6	$1,173.3	$10,827.7
Research, Development, Test and Evaluation funding	$594.4	$106.2	$113.0	$107.7	$107.9	$107.2	Continuing

Source: Fiscal Year 2025 President's Budget Request. I GAO-24-106546

[a]Prior Years Shipbuilding and Conversion funding reflects $6 million in advance procurement funding.

Frigate Contract Strategy

The Navy competitively awarded a fixed-price incentive (firm target) contract in combination with additional special performance incentive fees for frigate detail design and construction of up to 10 ships. Fixed-price incentive contracts generally include a profit adjustment formula referred to as a share line, as well as a target cost, target profit, and a price ceiling.[10] The structure of the share line establishes how cost overruns or underruns in relation to a target cost are shared between the government and shipbuilder up to the price ceiling. Generally, the share line functions to decrease the shipbuilder's profit as actual costs exceed the target cost. The price ceiling is generally the maximum the government will pay under the contract and is typically negotiated as a percentage of the target cost.[11] The target cost generally informs the share line and price ceiling.

[10]There are two types of fixed-price incentive contracts: fixed-price incentive (firm target) and fixed-price incentive (successive target). Fixed-price incentive (firm target) contracts are commonly used in Navy shipbuilding programs. In contrast, fixed-price incentive (successive target) contracts are rarely used in Navy shipbuilding programs. For purposes of this report, when we refer to fixed-price incentive contracts, we mean fixed-price incentive (firm target) contracts under the larger umbrella of fixed-price incentive type contracts. For more information on the Navy's use of fixed-price incentive contracts for shipbuilding, see GAO, *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.: Mar. 1, 2017).

[11]The government may pay for adjustments under other contract clauses that are unrelated to the contract price ceiling. See FAR § 16.403-1(a).

Leading Ship Design Practices

In May 2009, we identified commercial shipbuilding best practices that the Navy could adapt to improve program outcomes.[12] In May 2024, we updated this work to reflect new advances in design practices undertaken by leading commercial shipbuilders.[13] However, many of the key practices remained generally consistent with the practices identified in our 2009 report. As part of the April report, we recommended that the Navy take several actions to improve design knowledge before beginning construction on new shipbuilding programs, among other things, to which the Navy generally concurred.[14]

Our 2009 and 2024 work together found leading shipbuilders rely on these practices to ensure increasing and sufficient degrees of maturity as design development progresses. Timely achievement of these practices is crucial for delivering new ships within cost and schedule estimates. Table 2 outlines the specific design practices by phase.

[12]The results from our work over the last 15 years demonstrate that leading practices from commercial industry can be applied thoughtfully to Navy shipbuilding acquisition to improve outcomes, even when cultural and structural differences yield different sets of incentives and priorities. As part of our 2024 and 2009 analyses on shipbuilding leading practices, we reported on the environments in which commercial and Navy shipbuilding operate. For additional detail on these differences, see GAO-24-105503 and GAO-09-322.

[13]GAO-24-105503.

[14]GAO-24-105503.

Table 2: Leading Practices for Commercial Ship Design

Design phase	Key tasks involved
Basic and functional design	• Fix ship steel structure and set hydrodynamics • Design safety systems and get approvals from applicable authorities • Route all major distributive systems, including electricity, water, and other utilities • Provide information on position of piping, ventilation, equipment, and other outfitting in each block • 3D model the ship structure and major systems, with reliable vendor-furnished information incorporated to support understanding of final system design. Reliable vendor-furnished information reflects a firm understanding of the characteristics for ship equipment and components, including requirements for space, weight, power, water, and other utilities. An example of reliable vendor-furnished information is having finalized specifications for a piece of equipment but awaiting the results of factory acceptance testing to validate those specifications through manufacturing
	Design stability achieved upon completion of basic and functional design
Detail design	• Use 3D modeling information to generate work instructions for each block—the basic unit of ship construction—that show detailed system information and support construction; includes guidance for subcontractors and suppliers, installation drawings, schedules, material lists, and lists of prefabricated materials and parts • At a minimum, complete detail design for any given block of the ship prior to beginning construction of that block

Source: GAO. I GAO-24-106546

Note: Ship buyers and builders may use different terms to denote the design phases. However, the tasks completed are the same regardless of terminology.

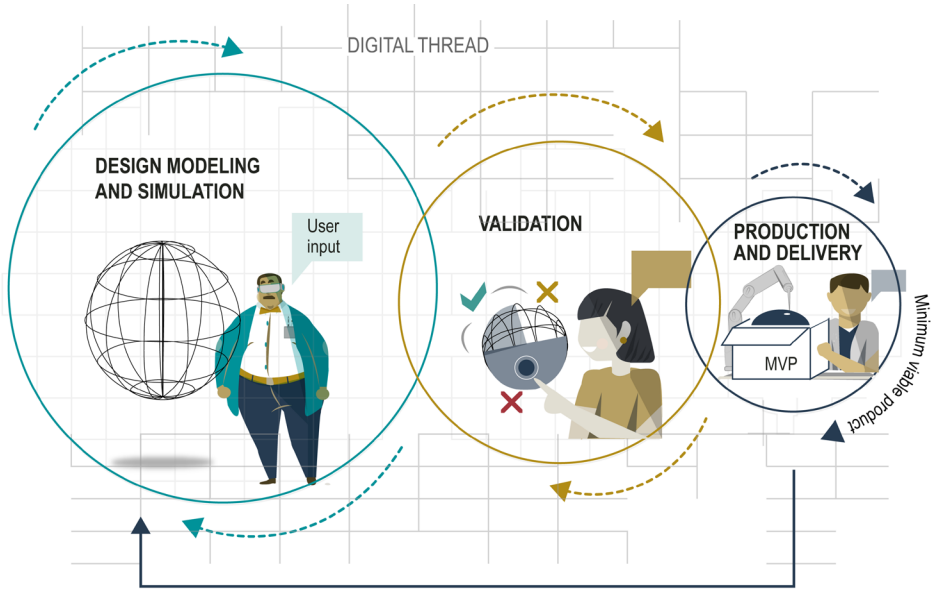
Leading Practices for Product Development

We have also performed work to identify leading practices for product development.[15] Although this work is not shipbuilding specific, we previously reported that these leading practices are generally consistent with ship design practices that commercial shipbuilders follow, including a shared focus on delivering relevant, essential capabilities to users quickly.[16] In July 2023, we found that leading companies structure product development efforts for complex, cyber-physical systems—co-engineered networks of hardware and software, such as aircraft and uncrewed vehicles—around three iterative cycles, which serve to design, validate, and deliver the systems to users and customers with speed. Figure 4 depicts the three iterative cycles leading companies use.

[15]GAO-23-106222 and GAO-22-104513.

[16]GAO-24-105503, GAO-23-106222, and GAO-22-104513.

Figure 4: Leading Companies Progress through Iterative Cycles to Develop a Minimum Viable Product



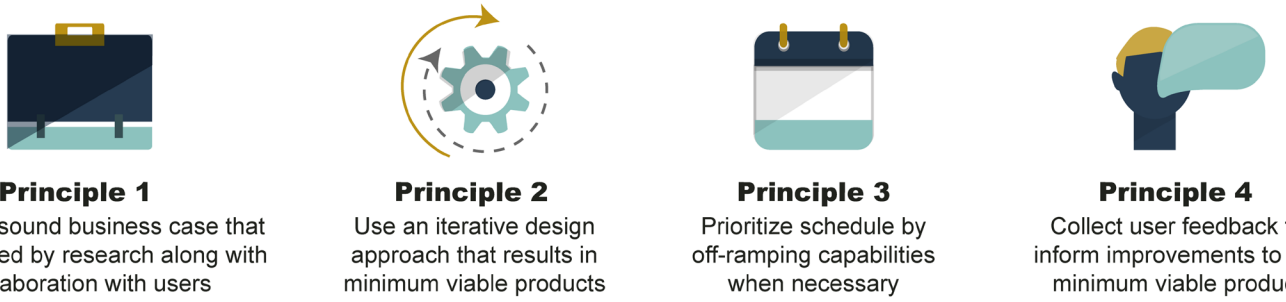
Source: GAO analysis of leading company information; GAO (illustration). | GAO-24-106546

Leading companies continually exchange information among these three cycles, which are underpinned by a digital thread that enables test and design data to be shared among developers, users, and other stakeholders in real time.[17] These companies use modern design tools, such as digital twins and virtual reality, to allow this exchange of information and more accurate prototyping. Through this iterative design process, developers, customers, and users partner together on a journey that translates general, high-level product requirements into specific product requirements. These specific product requirements are demonstrated through digital twinning and prototyping as meeting users' and customers' most essential needs and are producible within the allotted schedule and budget. The resulting "minimum viable product," once delivered, then provides a new starting point for subsequent iterations (improvements) to the product.

[17]The digital thread is a common source of information that helps stakeholders make decisions, such as determining product requirements, throughout the product's life.

In March 2022, we identified four principles that guide product development efforts within leading companies.[18] These principles are not consecutive in nature. Rather, they are established early in product development and revisited and refreshed constantly thereafter. In our July 2023 report, we refined our language describing these four principles, given the essential role we found that they play in propelling the three cycles of iterative development.[19] Figure 5 identifies these principles.

Figure 5: Leading Principles for Product Development



Source: GAO analysis of company information; GAO (icons). | GAO-24-106546

As part of our March 2022 work, we found that the Department of Defense's (DOD) primary, department-wide acquisition policies partially implement the four principles and most of their accompanying sub-principles (see appendix II for listing of sub-principles).[20] Our work found that the DOD policies include multiple examples of language that support attaining a sound business case, iterating on design, prioritizing schedule through a realistic assessment of product development activities, and collecting end-user feedback. We made four recommendations that DOD update its acquisition policies to fully implement the four principles throughout development. DOD concurred with the recommendations and noted that it will consider incorporating them when it next updates its acquisition policies, planned to be completed in June 2024.

[18]GAO-22-104513.

[19]GAO-23-106222.

[20]GAO-22-104513.

Design Review Practices and Inadequate Metrics Obscured Progress and Drove Inflated Expectations of Construction Readiness

The Navy and its shipbuilder leveraged an existing ship design to reduce technical risk and deliver frigates sooner. However, the Navy's decision to approve the shipbuilder to begin construction with an incomplete design is inconsistent with leading ship design practices, jeopardizing this strategy. Persistent shipbuilder delays in completing the design have also created mounting construction delays, rendering the April 2026 contract delivery date for the lead frigate unachievable. While the Navy tracks design progress, its process to calculate design stability hinges largely on the quantity—rather than the quality—of completed design documents. The focus on quantity obscures functional design progress and how much design work remains. Program challenges and delays have increased estimated contract costs; however, the Navy's fixed-price incentive contract helps limit cost risks.

Unstable Functional Design Has Caused Ongoing Detail Design and Construction Challenges

We found leading ship design practices include, among other essential elements, that leading commercial shipbuilders ensure the functional design of a ship is complete prior to beginning construction.[21] Beginning construction with an incomplete functional design increases the risk of design changes and the subsequent costly rework and out-of-sequence work that these changes trigger. We have previously reported that design stability is achieved upon completion of a basic and functional design in a 3D model, using reliable vendor-furnished information incorporated to support an understanding of final system design, among other things.[22]

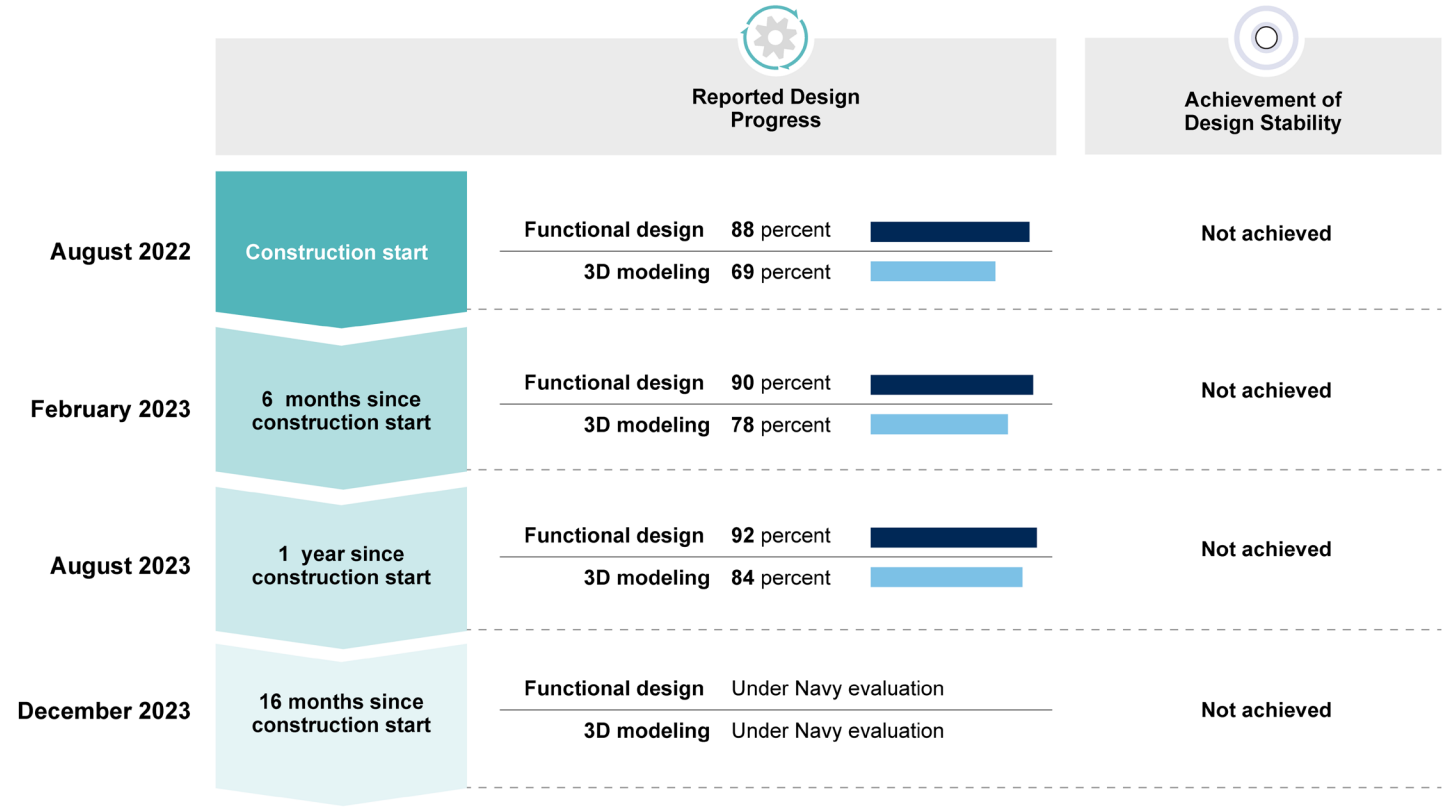
The Navy began frigate construction in August 2022 with an incomplete functional design, counter to leading ship design practices. The Navy and shipbuilder continue to finalize key functional design documents over a year after construction began. For example, as of December 2023, the program's functional design and 3D model remained incomplete. We found that delays in completing the functional design have had a cascading effect on other design activities, including 3D modeling, detail design, and development of work instructions needed to build the ship. These delays have stalled construction progress and jeopardized the Navy's approach to reduce technical risk and deliver frigates sooner by leveraging an existing ship design. For example, the Navy reported that, as of September 2023, the shipbuilder had completed construction of only 3.6 percent of the lead ship as compared to the 35.5 percent it was scheduled to have completed by that point.

[21]GAO-24-105503.

[22]GAO-24-105503.

Figure 6 presents our analysis of the frigate program's reported functional design and 3D modeling progress, dating back to the August 2022 lead ship construction start, and is based on the program's established design review metrics.[23]

Figure 6: GAO Analysis of Frigate Design Progress since Navy Approved Construction Start



Source: GAO analysis of Navy reported design progress. | GAO-24-106546

Note: This analysis reflects the frigate program office's reported functional design and 3D modeling progress at the end of the months noted in the figure. The frigate program office measures functional design progress based largely on the quantity of submitted contract deliverables. Further, the program's measure of functional design did not include 3D modeling. Leading ship design practices include 3D modeling of functional design to demonstrate design stability before beginning construction. Reported percentages are approximations based on Navy design progress curve data. The program office forecasted 100 percent completion of functional design and 3D modeling activities by August 2023. A Navy official confirmed that, as of March 2024, Navy leadership was evaluating frigate functional design and 3D modeling progress results for December 2023. The Navy provided no further information on the status of design progress for December 2023.

[23]We discuss shortcomings in the Navy's metrics for measuring frigate design progress later in this report. Nonetheless, these are the data that the Navy relied on to evaluate the program's design progress and inform the construction decision.

The Navy implemented its unique specifications in 511 functional design documents—referred to as "contract data requirements list (CDRL) items"—to incorporate its weapon systems, more robust damage control systems, and a newly designed topside arrangement, among other things. However, the Navy and shipbuilder continue to grapple with these CDRL items—drawings, diagrams, specifications, and configurations that inform the 3D model and detail design—in tandem with constructing the lead frigate.

As of February 2024, over a year and a half after beginning construction, the Navy and its shipbuilder had successfully closed (approved) 168 CDRL items while another 343 remained open (not approved). The Navy and its shipbuilder categorize several of the 343 open CDRL items as "priority CDRLs". These priority CDRL items affect multiple design documents and, in some cases, traverse multiple "grand modules" (the frigate program office's term for blocks) of the ship. Closing these CDRL items has proven more challenging and taken longer than anticipated. For example, in July 2022, the shipbuilder projected closure of 47 priority CDRL items by January 2023. The number of priority CDRL items grew from 47 identified in July 2022 to 70, as of October 2023. As of this date, the Navy and shipbuilder, however, had closed only 15 priority CDRL items.

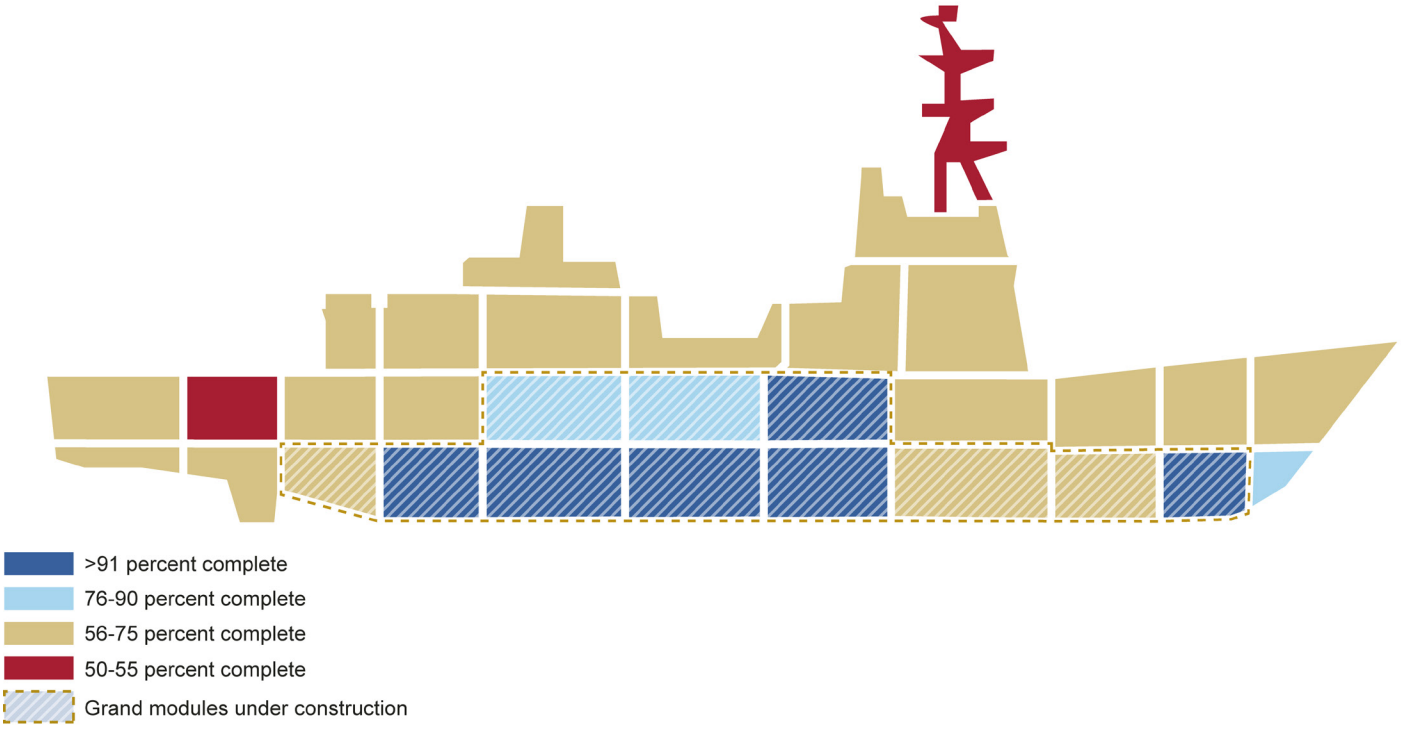
According to program officials, the increase in priority CDRL items reflects the Navy's and shipbuilder's focus on completing critical, open design documents needed to support construction. In other words, this increase does not reflect added design scope to the existing contract but reflects the program's increased focus on finalizing key design details, including design details for interdependent and distributive systems. However, until these design documents are closed (approved), the shipbuilder cannot complete the ship's 3D model, from which the shipbuilder develops the detail design for individual grand modules.

Further, according to leading ship design practices, construction on a block (or grand module) of a ship should not commence until that block's detail design is complete.[24] Leading commercial shipbuilders rely on this completion to ensure that construction of blocks progresses in a timely and efficient manner. However, the frigate shipbuilder began constructing grand modules that have an incomplete detail design, inconsistent with

[24]The frigate program office uses the terminology "grand module" instead of "block" to describe the basic unit of construction for the ships. GAO-24-105503.

this leading practice. Consequently, without completing detail design before beginning construction on a block, the frigate shipbuilder now likely confronts two undesirable outcomes: either (1) costly rework and out-of-sequence work or (2) further stalling construction to await design completion. Figure 7 shows the shipbuilder's assessment of 3D modeling completion by grand module as of October 2023—over 1 year after construction began.

Figure 7: Shipbuilder Assessment of Frigate 3D Modeling Progress by Grand Module (October 2023)



Source: GAO (analysis); Navy (image and data). | GAO-24-106546

Note: The percentage reflects a collective average generated by GAO of 3D modeling completion based on individual percentages for six elements—structural; outfitting; machinery; electrical; heating, ventilation, and air conditioning; and auxiliary.

By November 2022, the Navy concluded that its shipbuilder was unlikely to meet the April 2026 contract delivery date for the lead ship. In a May 2023 letter to the shipbuilder, the Navy observed that design progress had not sufficiently progressed to sustain the construction and delivery schedule. The Navy requested the shipbuilder develop a plan of action to restore execution of its plan for developing design documents to support

the ship's construction and any necessary mitigation steps until this is achieved. We found the program experienced continual delays completing the detail design since construction began. More recently, in December 2023, the Navy reported that the shipbuilder forecasted that ongoing construction delays would postpone lead ship delivery to December 2027—roughly 20 months later than the contract delivery date.

In January 2024, the Secretary of the Navy initiated a comprehensive assessment of Navy shipbuilding challenges. This assessment reviewed the shipbuilding industrial base—and its capability to execute programs, such as the frigate and *Columbia* class submarine, on schedule.[25] In April 2024, the Navy released the results of the assessment, finding new delays affecting several of its programs. For frigate, the assessment concluded that lead ship delivery would likely be delayed an additional 16 months beyond the Navy's previously estimated delay of about 20 months. This total estimated 36-month delay corresponds with shipbuilder delivery of the lead frigate in 2029—nearly 7 years after construction start. The results of the assessment did not include an estimate of delivery delays for the other three frigates under contract (FFG 63 through FFG 65), although program officials stated that the lead ship findings will inform subsequent determinations of new dates for construction and delivery of follow-on ships.

A complicating factor in assessing new dates for frigate deliveries is the shipbuilder's October 2023 reporting of unplanned weight growth in the frigate design—an increase of over 10 percent above the shipbuilder's June 2020 weight estimate. The Navy's decision to approve construction with incomplete elements of the ship design—including information gaps related to structural, piping, ventilation, and other systems—and the underestimation of adapting a foreign design to meet Navy requirements have driven this weight growth. Resolving this weight growth adds another dimension to the shipbuilder's ongoing design activities, further diminishing the predictability of these already schedule-challenged efforts. Further, as we previously found in a July 2014 report evaluating the LCS program, unplanned weight growth during ship construction can compromise ship capabilities in the short term (i.e., upon delivery of the ship to the fleet) and in the long term, as the fleet seeks to alter and improve initial capabilities over the planned decades-long service life of

[25]We have ongoing work evaluating the *Columbia*-class submarine program.

the ship.[26] In December 2023, the Navy initiated a separate review of frigate weight growth to assess risk. The Navy disclosed to us in April 2024 that it is considering a reduction in the frigate's speed requirement as one potential way, among others, to resolve the weight growth affecting the ship's design.

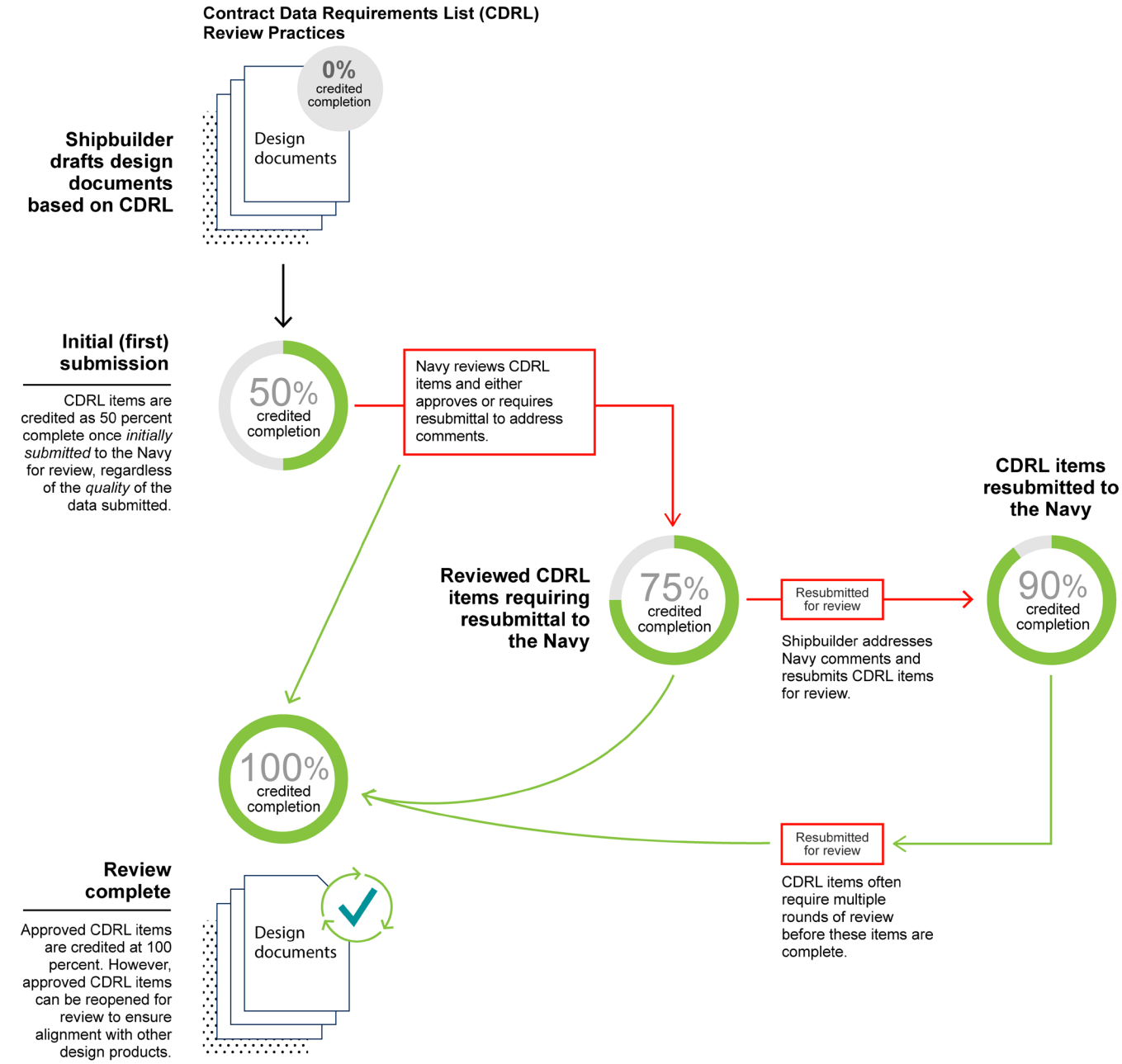
Metrics Based More on Quantity Rather Than Quality of Design Deliverables Obscure Design Instability

Inadequate design review practices and metrics have obscured the Navy's visibility into frigate design progress and remain an obstacle to forecasting realistic ship delivery dates. The Navy computes and tracks functional design stability based predominantly on the quantity of CDRL items the shipbuilder has submitted for Navy review rather than on the quality of those submitted CDRL items. For example, the program's calculated functional design stability at construction start was based on a metric that scores design CDRL items as 50 to 75 percent complete merely because the shipbuilder had submitted them to the Navy but did not consider the quality of the CDRL item.

Navy engineering officials noted instances where the Navy received items largely incomplete and, in some cases, without any design content from the frigate shipbuilder—an occurrence the Navy officials attributed to the contractor's desire to meet a contract deadline for submitting a given CDRL item. In such instances, the Navy has credited these largely incomplete CDRL items as 50 percent complete. These practices and metrics caused the frigate's functional design to appear more complete than what had been achieved. Figure 8 further details the Navy's practices and metrics for assessing functional design progress.

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

Figure 8: Illustrative Example of Navy Practices and Metrics for Measuring Frigate Functional Design Progress



Source: GAO analysis of Navy and shipbuilder information. | GAO-24-106546

We found that CDRL items have often required multiple rounds of review between the Navy and shipbuilder to address comments and close the items as completed. For example, in July 2022, the shipbuilder was responding to over 170 critical comments it received from the Navy on one of the 26 supporting documents that comprise the structural design CDRL item. The structural design was the first part of the frigate design developed by the shipbuilder and accounts for 20 percent of the overall frigate design, according to program officials. As of July 2023, program officials stated the structural design was highly mature—even though the majority of the 26 supporting documents remained incomplete.

Counter to the frigate design review practices and metrics outlined above, our leading ship design practices work recently found that commercial shipbuilders generally focus on key ship design knowledge attained when evaluating design maturity and making decisions on construction readiness. This knowledge stems from design product approvals, vendor-furnished information completeness, and material availability for construction—rather than calculations of design completion.[27]

Navy policy affords the decision authority for its shipbuilding programs the flexibility to define specific practices and metrics it determines are most appropriate to calculate functional design progress.[28] According to program officials, they implemented the current practices and metrics to provide better visibility of design progress than what would be provided under a binary approved/not approved measure. However, the Navy's design review practices and metrics neither afford clear visibility into frigate design progress nor provide a realistic basis for forecasting schedules for future frigates, including the second ship (FFG 63) which has yet to begin construction. Developing metrics that consider the quality of the design deliverable would provide the Navy a more accurate gauge of the shipbuilder's design progress. Without modifying these metrics before beginning construction of follow-on ships, Navy acquisition leadership is ill positioned to advise fleet operators and Congress on

[27]GAO-24-105503.

[28]Secretary of the Navy, *Department of the Navy Implementation of the Defense Acquisition System and the Adaptive Acquisition Framework,* SECNAV Instruction 5000.2G (Apr. 8, 2022). In May 2024, we recommended that the Secretary of the Navy establish guidance outlining the information and evaluation methodology used to certify the completion of basic and function design prior to a ship's construction start for any major shipbuilding program. See GAO-24-105503.

when these frigates are likely to be delivered and available for mission tasks.

Frigate Contract Limits Navy's Liability for Cost Growth Resulting from Design Challenges

The Navy's decision to negotiate a fixed-price incentive (firm target) contract in combination with additional special performance incentive fees for frigate detail design and construction represented a significant departure from previous Navy surface combatant shipbuilding programs. The Navy often uses cost-reimbursement contracts for detail design and construction of lead and, at times, early follow-on ships, under which the government generally bears the risk of cost, schedule, or ship performance problems.[29] In using a fixed-price incentive contract, the Navy has currently limited its cost risk to the combined total of ceiling prices for the four frigates currently under contract—roughly $2.5 billion.

Although construction of the lead ship was less than 10 percent complete as of December 2023, the shipbuilder's estimated cost for delivering the lead frigate has risen above the contract ceiling price. Program officials and shipbuilder representatives attributed the estimated cost growth on the contract to several factors. Factors cited by both the program office and shipbuilder included, among other things, design challenges and associated design costs and higher than expected material and labor costs, some of which are due to inflation. Program officials noted another factor was the shipbuilder's aggressive bids on materials with subcontractors, many of which did not work out.

The contract terms and conditions for the lead frigate limit the government's responsibility for cost overruns to a 70 percent share of costs above target cost up to the contract ceiling price (120 percent of the target cost). As a result, the government will be responsible for funding the majority of cost overruns up to the ceiling price. However, in general, any allowable incurred costs above that ceiling price are absorbed by the frigate shipbuilder. For the nine follow-on ships included as options in the frigate contract, the contract terms further reduce the government's responsibility for cost overruns via lower share lines above target cost and, for most ships, lower ceiling prices (as compared to the lead frigate).

[29]GAO-17-211. Cost-reimbursement contracts require the government to pay all allowable incurred costs, to the extent prescribed in the contract. Under this contract type the contractor agrees to use its best efforts to meet contract requirements within the estimated cost. However, the government is not promised a completed item (e.g., ship) within that cost.

Construction Delays Afford Opportunity to Improve Testing Plans for Key Systems

To reduce developmental and technical risks, the frigate program is leveraging many mission systems already proven on other Navy ships. However, the Navy has yet to demonstrate two critical major systems—the propulsion and machinery control systems. The propulsion system has never been fielded on a U.S. Navy ship. The control system is a new system specifically developed for the frigate. The Navy does not currently plan to fully test these systems on land before delivering the lead ship. Conducting initial land-based testing could reduce the risk of discovering issues after the lead ship is delivered and at sea. A planned 2025 update to the frigate test plan—combined with delays to the lead ship's delivery date—could offer the program the chance to do land-based testing of these two unproven systems.

Frigate Capabilities Rely Largely on Existing Systems, but Propulsion and Machinery Control Systems Are Undemonstrated

The Navy's approach to fielding frigates quickly and affordably relies largely on leveraging existing mission systems to reduce technical risk. We previously reported that using more mature, existing systems better positions programs to fulfill capability needs while limiting developmental risks.[30] The program's acquisition strategy includes a requirement for all integrated systems to have achieved maturity by relying on technology that is, at a minimum, a representative model or prototype demonstrated in a relevant (less than fully realistic) environment. However, the program's measure of technology maturity is inconsistent with our technology readiness best practices, which established that technologies are mature once the technology is demonstrated in a realistic environment.[31] While the program reported that it does not have any new or novel technologies, our analysis found that some of the frigate systems will pose various levels of developmental and integration risk.

Our assessment of seven systems found that five systems present low to medium risk or medium risk, while two others—propulsion and machinery centralized control—present high development and integration risk (see table 3).

[30]GAO-24-105503 and GAO-09-322.

[31]GAO, *Technology Readiness Assessment Guide: Best Practices for Evaluating the Readiness of Technology for Use in Acquisition Programs and Projects [Reissued with revisions on Feb. 11, 2020.]*, GAO-20-48G (Washington, D.C.: Jan. 7, 2020).

Table 3: Summary of GAO Assessment of Development and Integration Risks Posed by Selected Frigate Systems

System name	GAO assessed risk level	Rationale for GAO's assessed risk level
Mk 41 Vertical Launch System (VLS)	Low to medium	VLS is a legacy system fielded on Navy destroyer and cruiser classes. However, integrating VLS on the frigate requires software updates to VLS and Aegis, therefore posing potential integration risk.
AN/SLQ-32(V)6 Electronic Warfare System	Low to medium	AN/SLQ-32(V)6 Electronic Warfare System is fielded on multiple ship classes. However, the software portion of the system includes planned frigate specific updates, therefore posing potential integration risk.
Enterprise Air Surveillance Radar (AN/SPY-6(V)3)	Medium	AN/SPY-6(V)3 is a scaled down version of the AN/SPY-6(V)1 radar fielded on the DDG 125 destroyer. The program plans to apply lessons learned from installing AN/SPY-6(V)3 on the CVN 79 aircraft carrier, leverage DDG 125 at-sea testing, and conduct land-based testing with the Aegis Weapon System (Aegis Baseline 10.F) to reduce integration risk. While relevant at-sea testing on DDG 125 is scheduled to complete around the same time as lead frigate delivery, AN/SPY-6(V)1 is a different version than AN/SPY-6(V)3—limiting its utility in reducing integration risk of AN/SPY-6(V)3 on the frigate. Additionally, the Navy cannot fully demonstrate AN/SPY-6(V)3 aboard frigate until the lead ship is at sea.
Aegis Weapon System (Aegis Baseline 10.F)	Medium	Aegis Baseline 10.F is an updated version of the combat system currently fielded on DDG 125. Like AN/SPY-6(V)3, the program plans to conduct frigate-specific land-based testing as well as leverage data from DDG 125 testing to inform Aegis Baseline 10.F integration and development. However, DDG 125 testing will not be complete prior to Aegis shipboard integration on the lead frigate. Additionally, the Navy cannot fully demonstrate Aegis aboard frigate until the lead ship is at sea.
Anti-Submarine Warfare Combat Suite and related systems: AN/SQQ-89(V)16, Undersea Warfare Decision Support System, Multi-Function Towed Array, and Combined Active Passive Towed Array Sonar (CAPTAS-4C)	Medium	Three of the four subsystems are systems that individually are fielded on various Navy ship classes. The fourth system, CAPTAS-4C, has been fielded on foreign navy vessels, but has not been integrated on Navy ships nor integrated with AN/SQQ-89(V)16. The Navy does not expect to fully demonstrate CAPTAS-4C until after delivery of the lead frigate.
Combined Diesel-Electric and Gas Turbine Propulsion System	High	The Navy has not previously used this propulsion system on any ships. While foreign navy vessels use the system, the frigate will use a different configuration. The Navy has experienced challenges and at-sea failures in the recent past with certain propulsion systems. However, its current test plans do not provide for land-based testing of the propulsion system until after lead frigate delivery. This increases the likelihood of discovering deficiencies while the ship is at sea, which could limit fleet availability.
Machinery Centralized Control System (Control system)	High	Machinery control systems have consistently posed challenges to new Navy ships in recent history. The frigate's control system is a new and unique design comprised of over 95 percent new software. While components of the control system are simulated in a lab, the Navy does not plan to fully demonstrate the control system with the propulsion system until after lead frigate delivery. This increases the likelihood of discovering deficiencies while the ship is at sea, which could limit fleet availability.

Source: GAO analysis of Navy and contractor documentation and testimonial evidence. I GAO-24-106546

Note: To categorize the level of development and integration risk selected systems pose, we evaluated whether each system (1) has been fielded on other ship classes, (2) has been or will be tested on land prior to lead ship delivery, and (3) will be operationally (fully) demonstrated on other

U.S. Navy ship classes prior to FFG 62 delivery. We also evaluated other factors that reduce or increase system risk (additional details on our criteria are included in appendix I). We used December 2026 as the lead ship delivery date, as it was the estimated delivery date at the time of the analysis.

Combined Diesel-Electric and Gas Turbine Propulsion System

Although certain foreign vessels currently operate with a combined diesel-electric and gas turbine propulsion system, the configuration the Navy plans to use for the frigate has never been fully demonstrated or fielded on a Navy ship. The frigate propulsion system will include a combined diesel-electric and gas turbine, two electric propulsion motors, a reduction gear, and two fixed pitch propellors, among other components. Although similar in overall architecture to the propulsion system used in the Italian frigate—the parent design of the Navy's frigate—the frigate propulsion system required design changes to meet Navy requirements and standards. This increased cost and introduced integration risks, according to shipbuilder representatives. As a result, the Navy redesigned components to be different from the Italian frigate propulsion system. Table 4 below compares the propulsion systems planned for the Navy frigate and used on the Italian frigate.

Table 4: Comparison of Propulsion System Components Planned for Navy Frigate and Used on the Italian Frigate

Component	Description of changes, if applicable
Gas turbine	Same—No change
Electric propulsion motor	Different—More powerful propulsion motors to increase speed and electric power
Ship service diesel generator	Different—More powerful diesel generators that have higher voltage to increase speed and electric power
Main reduction gear	Different—Newly designed main reduction gear to meet Navy requirements
Propellor	Different—Newly designed fixed pitch propellors designed to increase ruggedness and reliability

Source: GAO analysis of Navy and contractor documentation and testimonial evidence. I GAO-24-106546

Machinery Centralized Control System

The Machinery Centralized Control System serves as the user and control interface for 45 subsystems on the frigate, including alarms, water systems, and the propulsion system. The control system developer, L3Harris, has taken some steps to reduce the technical risk from obsolescence, among other things, for the frigate's control system. For example, L3Harris representatives said they have moved to open-source tools as opposed to proprietary software solutions used on machinery control systems on previous ship classes. We previously found that using open-source software has the potential to provide cost savings and

increase efficiency.[32] According to the control system developer, open-source software will allow for greater longevity to the frigate control system by lowering the chance of obsolescence and giving the Navy flexibility in future upgrades to the control system. In addition, the control system developer has initiated testing of subsystem hardware and software at its land-based system integration lab to simulate the control system operating various subsystems to identify and mitigate issues.

However, the control system faces risks from new software code and limitations of developer simulation testing. For example, L3Harris representatives explained that the frigate's control system is made of roughly 95 percent new software code due to major changes from the parent ship design and integration with new equipment and systems. These representatives also stated that the builder of the control system used in the parent design used proprietary tools. This prevented L3Harris from using its developmental tools when developing its control system for the frigate. Additionally, the simulation testing uses models that do not account for all the operating environments in which the Navy expects the frigate to perform, according to L3Harris representatives. As a result, the simulated testing of the control system, while helpful, does not provide the same risk-reduction benefits that land-based testing with actual propulsion system hardware would provide.

Further, Navy officials emphasized the biggest risk lies in integrating propulsion system components—gas turbine, diesel engines, electric propulsion motors—with the control system and integrated power system. Integrating these systems is necessary to ensure all the individual components work in unison to power the propulsion system.

Frigate Delays Could Offer Opportunity for Added Testing to Demonstrate High-Risk Systems' Capabilities

The William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 includes a provision that requires the Secretary of the Navy, before the lead ship's delivery date, to commence a land-based test program for the engineering plant of the frigate class of vessels.[33] Navy officials stated that congressional interest in funding a Land Based Engineering Site (LBES) had increased after recent ship classes, such as the LCS, experienced costly propulsion challenges and failures that could have been identified and mitigated earlier with land-based testing. LBES

[32]GAO, *Information Technology: DOD Needs to Fully Implement Program for Piloting Open Source Software*, GAO-19-457 (Washington, D.C.: Sept. 10, 2019).

[33]William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, §125.

also provides the Navy with the ability to continuously test propulsion components for later hulls to help keep ships at sea longer. This approach is consistent with the LBES testing that the *Arleigh Burke* class destroyer (DDG 51) program has done for years. Figures 9 and 10 depict images of LBES.

Figure 9: *Arleigh Burke* Class Land Based Engineering Site Control Center

Source: Navy. | GAO-24-106546

Figure 10: *Arleigh Burke* Class Land Based Engineering Site

Source: Navy. | GAO-24-106546

LBES will have a representative frigate propulsion plant that will include a gas turbine, diesel engines, a reduction gear, electric propulsion motors, and a full control system, among other components needed to control the propulsion system. The Navy began construction of the frigate LBES in late fiscal year 2022 at the Naval Surface Warfare Center, Philadelphia Division. However, Navy officials do not expect the site to be fully online and available for frigate testing prior to the previously forecasted lead ship delivery date of December 2026. Therefore, the Navy currently plans to use LBES as a reactive test bed platform to troubleshoot propulsion plant and control system issues that are discovered after the lead frigate is delivered and at sea.

However, the Navy now forecasts lead frigate delivery in 2029, which opens the door to revisiting the Navy's plans for how and when it uses LBES to test frigate propulsion and control systems. This delay provides the Navy an opportunity to identify a path forward that uses LBES for proactive, discovery focused testing of the propulsion and control systems—with an eye toward identifying and resolving deficiencies in a less jeopardizing environment than after a problem has occurred aboard the lead ship at sea.

As the frigate acquisition is a DOD program with an expected cost of over $22 billion, the Navy was required to develop a Test and Evaluation Master Plan (TEMP). The Director of Operational Testing and Evaluation (DOT&E) approved this TEMP in June 2020.[34] DOD policy establishes that the TEMP capture the program's testing requirements, the rationale for those requirements, and the resources needed to complete the testing.[35] The frigate TEMP includes information on the testing goals and objectives for the frigate, including detailed sections on the land-based testing of certain mission systems. While the TEMP reflects that LBES may be leveraged to support hull, mechanical, and electrical testing, it does not identify the specific plans, objectives, and resources, among other things, needed to test the propulsion and control systems at LBES. This is because the LBES legislative provision was enacted after DOT&E had approved the frigate TEMP. The Navy already plans to update the frigate TEMP in fiscal year 2025, which presents a natural opportunity for the Navy to identify LBES testing resources and plans in the TEMP.

Separate from the TEMP, Navy officials have begun developing the frigate LBES test plan. According to officials, Navy leadership is scheduled to review this plan by late fiscal year 2024. The test plan will outline the resources, test types, and objectives, among other things, to support LBES testing. Frigate program officials stated though that they do not plan to update the TEMP with LBES testing activities. Officials also stated that LBES testing is outlined under two live fire testing objectives already captured in the TEMP. Our review of the TEMP found that the two testing objectives noted by the program office do not detail how the program plans to use LBES—a substantial, multi-million-dollar investment by the government on behalf of the frigate program. According to DOD guidance, programs should update the TEMP as new data are collected and as the program reaches new acquisition milestones and decision points.[36] Without updating the TEMP to reflect LBES test activities and objectives, the Navy and other DOD stakeholders will not be afforded clear insight into the testing objectives, activities, and resources that the program anticipates pursuing to support LBES. There will also be limited

[34]DOT&E approved the frigate program's TEMP with the exception of the plan's strategy for testing the anti-air warfare mission capability. In a June 2020 memo to the Assistant Secretary of the Navy for Research, Development and Acquisition, DOT&E expressed concerns with the Navy's anti-air warfare test approach and requested the Navy provide an updated anti-air warfare strategy in a future TEMP revision.

[35]Department of Defense, *Test and Evaluation,* DOD Instruction 5000.89 (Nov. 19, 2020).

[36]*Test and Evaluation Enterprise Guidebook* (August 2022).

insight into how LBES testing is integrated with other frigate testing activities and a revised schedule for lead ship delivery.

Iterative Approaches Hold Potential to Help Frigate Program to Deliver Capabilities More Quickly

The Navy's acquisition strategy for the frigate is structured as a traditional, linear development effort, though it did incorporate certain elements of our leading practices for product development. The Navy has historically experienced challenges in its shipbuilding programs that have employed linear development approaches, including schedule delays, cost growth, or both. Developing an acquisition strategy structured around iterative cycles could help the Navy deliver future frigates to the fleet at a faster pace and with increased assurance that their capabilities are matched to evolving mission needs.

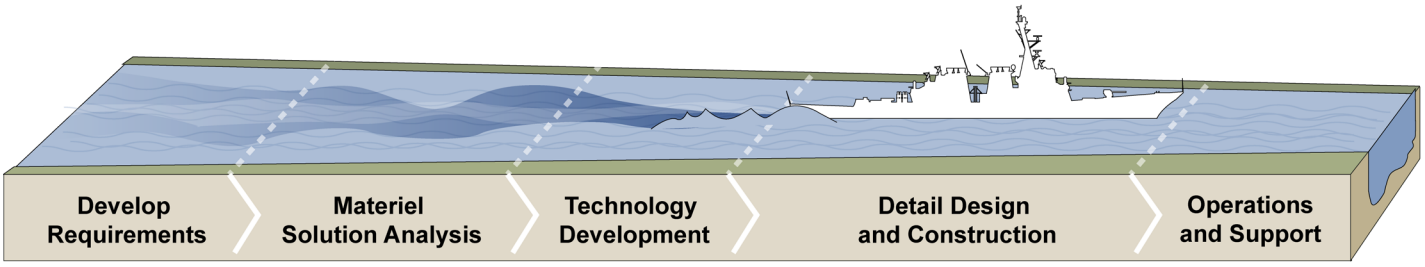
Frigate Acquisition Strategy Is Currently Structured Around Linear Development but Has Incorporated Certain Leading Practices

The Navy is using a traditional, linear development pathway to design and construct frigates. This approach is outlined in the November 2022 frigate acquisition strategy covering the first 10 ships—a document that preceded our July 2023 report on leading practices for product development.[37] Specifically, the Navy is using the Major Capability Acquisition (MCA) pathway within DOD's Adaptive Acquisition Framework.[38] Figure 11 illustrates the linear development approach around which the Navy structured the frigate acquisition strategy.

[37]The November 2022 frigate acquisition strategy updated the September 2018 acquisition strategy by supporting the ship procurement profile, adding the Land Based Engineering Site requirement, including details on a potential second shipyard, and updates to support ship sustainment details.

[38]DOD established the Adaptive Acquisition Framework in January 2020. The Adaptive Acquisition Framework emphasizes several principles that include simplifying acquisition policy, tailoring acquisition approaches, and conducting data-driven analysis. Oversight of the department's costliest weapon systems is shared between several entities within the Office of Secretary of Defense and the military departments. *Operation of the Adaptive Acquisition Framework*, DOD Instruction 5000.02 (Jan. 23, 2020) (incorporating change 1, June 8, 2022).

Figure 11: Overview of the Navy's Linear Development Acquisition Approach



Source: GAO analysis of Navy documentation; GAO (illustration). | GAO-24-106546

Navy shipbuilding programs have historically struggled to deliver promised capabilities to users on schedule and fulfill identified fleet needs. Our previous work has identified several specific challenges that shipbuilding programs have encountered in the past, such as inexecutable business cases, long acquisition time frames, and requirements, funding, and schedule being set before designs are understood.[39] Inexecutable business cases often lead to overlap between technology development, system design, and construction and have historically led to cost growth and delays. In turn, long acquisition time frames decrease the relevance of a delivered capability and prevent capabilities from addressing dynamic user needs as the threat environment evolves. Finally, setting requirements, funding, and schedule before a design is understood often leads to inaccurate cost and schedule estimates and limits the Navy's ability to adapt requirements to meet actual production realities.

In recognition of some of the challenges, the Navy took several steps at the start of the frigate program to enhance its use of the MCA pathway. DOD's policy governing the MCA pathway prioritizes speed of delivery, continuous adaptation, frequent modular upgrades, and flexibility to tailor programs.[40]

[39]GAO, *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP (Washington, D.C.: June 6, 2018).

[40]Department of Defense, *Major Capability Acquisition,* DOD Instruction 5000.85 (Aug. 6, 2020).

The frigate acquisition strategy includes the following approaches, which are responsive to certain elements of our leading practices for product development:

- **Early user feedback.** According to program officials, the Navy consulted with potential fleet users to better understand user needs and desired capabilities. Program officials said they also consulted extensively with operators of the LCS—the precursor to the frigate—on lessons learned that could be applied to the frigate. For example, the Navy increased the range of the ship to be consistent with fleet operator priorities and to reduce demand for the limited number of refueling platforms.
- **Industry feedback and requirements modifications.** According to officials, the frigate program further consulted with industry during the conceptual design phase to mature different ship designs and identify opportunities for cost savings. This helped the program develop frigate requirements based on actual capabilities possessed by industry. In addition, program officials stated that they allowed for modifications to performance requirements longer than Navy shipbuilding programs have traditionally done, which enabled additional flexibility to modify a requirement based on learning through a design effort. These efforts somewhat align with our leading practices, though companies generally hold requirements open until the design is complete. We previously reported that industry representatives also noted that communication and activities during the conceptual design improved their understanding of the impetus for specific Navy requirements.[41] This allowed industry the opportunity to get clarification on the intent of some requirements, propose less costly alternatives, and obtain government feedback on proposed alternatives.
- **Parent design and modern design tools.** According to program officials, the use of a parent design reduced risk to the design process, although the shipbuilder has since encountered difficulties due to the need to revise the parent ship design to meet Navy standards. Program officials also recognized the importance of modern design tools. For example, officials said the shipbuilder uses digital tools, such as 3D modeling, to design and model the ship. The shipbuilder is also using an augmented reality tool to design the ship's bridge. Frigate subcontractors, such as L3Harris, also use a simulated configuration of a system integrated lab that can simulate software-

[41]GAO-19-512.

based modeling, though it cannot simulate equipment physics. This approach partially aligns with our leading practices for product development, but as the 3D model does not provide a dynamic capability, it would not be on the same standard as design tools used by leading companies.

- **Legacy systems.** The frigate program generally leveraged legacy combat systems that did not require extensive development. According to program officials, this approach was taken to reduce development risks. We have previously reported that this approach can reduce concurrency between technology development and design, which can improve acquisition outcomes.[42]

Leading Practices for Product Development Provide Opportunities to Rethink Frigate Acquisition Strategy for Future Ships

Though the program office has taken steps to implement some leading practices, additional opportunities exist to rethink the frigate acquisition strategy for follow-on ships to further incorporate leading practices. Moreover, we previously reported that these leading practices are generally consistent with ship design practices commercial shipbuilders follow.[43] Further incorporating leading practices, centered on structuring system development around three iterative cycles, could enable delivery of innovative, essential capabilities to users at a rapid speed—outcomes consistent with the Navy's frigate acquisition goals. For example:

- **Continuous stakeholder engagement.** Our leading practices recommend continuous engagement with stakeholders and users to inform the business case and subsequent design development. Leading companies continually seek feedback from customers and users not only during the requirements development phase, but during design modeling and simulation, validation, and production and delivery. Feedback ensures capabilities will meet the most critical user needs and that production facilities will be capable of handling those needs. Frigate program officials agreed that the program could collect such feedback throughout the program's life cycle.
- **Modern design tools.** Leading practices call for the use of modern design tools, such as digital engineering, a digital thread, and additive manufacturing as key enablers to iterative development for both hardware and software. These tools provide leading companies with dynamic capabilities that enable real-time communication with users and allow for the rapid incorporation of feedback to the product design

[42]GAO-18-238SP.

[43]GAO-24-105503.

and requirements. The program's current 3D modeling capability does not provide a digital twin of the ship, though officials said they are working toward a dynamic 3D model in the future that can be used to identify sustainment planning and maintenance. These officials agreed other tools, such as a digital twin, would be useful in designing the ship. Commercial shipbuilders also use modern design tools, such as digital twins and virtual reality, to accelerate design maturity and support efficiencies in design and construction.

- **Off-ramping less essential capabilities.** Leading companies off-ramp capabilities that present a risk to delivering the product on schedule—or that simply enable the most desirable capabilities (constituting a minimum viable product) to be delivered earlier. Off-ramping takes place throughout the design modeling and simulation and validation phases in response to continuous user feedback. Program officials recognized that off-ramping could provide benefits, even if, as officials explained, the current acquisition strategy makes it difficult in practice. For example, program officials explained that they off-ramped a less proven anti-submarine warfare suite component in favor of a more proven product that still met performance requirements, at a reduced schedule.

Currently, the Navy's acquisition strategy allows the option for a second shipbuilder in the future to build additional ships beyond the 10 currently under contract. Incorporating these leading practices into an updated acquisition strategy in time to help inform how best to design, develop, and produce the 11th ship and beyond would better position the program to respond to the dynamic needs of fleet operators quickly and iteratively.

Conclusions

The Navy embarked on the frigate program determined to achieve better outcomes than it has typically achieved when designing and constructing a new class of warship. Reliance on a parent design—and the finite scope of tailoring that it afforded—helped the Navy constrain its appetite for the new technologies that the frigate would introduce to the fleet. The Navy limited its cost risk with the use of a fixed-price incentive (firm target) contract for detail design and construction for up to the first 10 ships. Further, the Navy had good reason to be optimistic that the frigate program was positioned to deliver capabilities on the schedule it promised.

Subsequent missteps, however, have jeopardized the Navy's ability to achieve these goals. Navy decisions to substantially modify the frigate design from the parent design have caused the two to now resemble nothing more than distant cousins. Further, inadequate functional design

review practices and botched metrics that the frigate program continues to rely on obscured the program's actual design progress and contributed to prematurely starting lead ship construction before the design was sufficiently stable to support that activity. Now, over 18 months after lead ship construction start, the functional design remains unstable, which has undermined confidence in the accuracy and maturity of detail design products needed to construct grand modules—and construction progress has effectively stalled. The Navy and shipbuilder have resorted to correcting deficient drawings previously credited toward design progress, but the program continues to credit design progress based largely on quantity of deliverables rather than on the underlying quality of the document itself. Consequently, with construction start for the second frigate under evaluation, the Navy lacks visibility into the true scope of work remaining to stabilize the frigate's functional design and the extent to which ongoing delays in completing the design will have on construction of follow-on ships. It is, therefore, uncertain when fleet operators will have the new frigates available for mission tasks.

One silver lining of the delays is that they afford additional time to potentially demonstrate the capabilities of the frigate's propulsion and machinery centralized control systems on land (before lead ship delivery) rather than at sea (after lead ship delivery). Earlier discovery of any technical deficiencies affecting these two systems would yield an opportunity to make corrective fixes coincident with lead ship construction rather than after that ship delivers. This approach could reduce timelines for making the lead ship available for fleet use. However, the Navy has not indicated that it intends to consider the additional opportunities ongoing construction delays offer for land-based testing, as it updates the program's Test and Evaluation Master Plan.

Further, the Navy's ability to deliver frigates that match the evolving, dynamic needs of its fleet—on timelines that are responsive to those needs—warrants more broadly rethinking the frigate acquisition strategy. Taking stock of what opportunities exist for the frigate program to pivot toward leading practices, prior to acquiring ships beyond the 10 covered in the program's current contract, could help the Navy ensure that the capabilities that the frigate program delivers remain relevant and timely.

Recommendations for Executive Action

We are making the following five recommendations to the Navy:

The Secretary of the Navy should ensure that the frigate program's functional design review practices and metrics be restructured to measure

progress that reflects the quality rather than the quantity of design deliverables received from the shipbuilder. (Recommendation 1)

The Secretary of the Navy should ensure that the restructured functional design review practices and metrics established under recommendation 1 be used to assess whether the functional design is complete prior to beginning construction of the second frigate (FFG 63). (Recommendation 2)

The Secretary of the Navy should ensure that the detail design for any given grand module of lead and follow-on frigates be completed prior to beginning construction of that grand module, consistent with leading ship design practices. (Recommendation 3)

The Secretary of the Navy, as part of the planned revision of the frigate Test and Evaluation Master Plan, should ensure that the plan incorporates additional land-based testing activities for the propulsion system and machinery centralized control system and schedules those activities on a timeline that realistically accounts for anticipated lead ship delivery delays. (Recommendation 4)

The Secretary of the Navy, prior to acquiring an 11th frigate, should ensure that the Assistant Secretary of the Navy for Research, Development and Acquisition review the frigate program's acquisition strategy to identify opportunities to incorporate leading practices for product development and update that strategy, as appropriate. (Recommendation 5)

Agency Comments and Our Evaluation

We provided a draft of this report to the Navy in March 2024 for review and comment. In May 2024, the Navy provided written comments in response to our five recommendations. We reproduced the Navy's written comments in appendix III. The Navy also provided technical comments, which we incorporated as appropriate.

The Navy agreed with four of our recommendations and partially agreed with one recommendation. In response to our first and second recommendations, the Navy stated that it will ensure that the frigate program's design progress measurement incorporates the quality of the submitted design documentation and that functional design completion will provide exit criteria for the second frigate's production readiness review.

In response to our third recommendation, the Navy stated that it will continue to use the Module Readiness Review process to conduct a risk assessment—which includes a detailed design completion assessment of the specific grand module—prior to beginning construction on grand modules on lead and follow-on frigates. As we discussed in this report, construction on a grand module should not commence until that grand module's detail design is fully complete. The Navy also agreed with our fifth recommendation to update the frigate acquisition strategy as appropriate.

The Navy partially agreed with our fourth recommendation to update the frigate program's Test and Evaluation Master Plan (TEMP) to incorporate additional land-based testing activities and schedule those activities on a timeline that accounts for lead ship delivery delays. In its comments, the Navy stated that it does not intend to update the TEMP to include these additional test objectives because it views sustainment as the primary focus of the Land Based Engineering Site (LBES). However, the Navy stated that it will leverage early opportunities for additional risk reduction efforts as the LBES facility becomes available for use. The Navy expects the facility to be complete in fiscal year 2029.

We believe the Navy's planned steps are inadequate and therefore maintain that our recommendation should be implemented. The TEMP is to capture a program's testing requirements, the rationale for those requirements, and the resources needed to complete the testing. Correspondingly, LBES constitutes a congressionally-mandated testing requirement and resource for the frigate program. It is also important to remember that the Navy already plans to update the frigate TEMP in fiscal year 2025. By not seizing that existing opportunity to deliberate and reach agreement on LBES plans and usage among the program's test and evaluation stakeholders, the Navy risks underutilizing the full benefits that this multi-million-dollar program investment has to offer.

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

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

Shelby S. Oakley
Director, Contracting and National Security Acquisitions

Appendix I: Objectives, Scope, and Methodology

This report assesses (1) progress the Navy and its shipbuilder made in completing the frigate design and constructing ships within planned cost and schedule; (2) the extent to which technical uncertainties pose risk to planned capabilities for frigates and the Navy's plan to resolve these uncertainties; and (3) future opportunities to incorporate leading practices for product development within the frigate program.

To assess design and construction progress of the frigate program, we reviewed documentation related to design and construction efforts of the lead frigate, including design progress metrics, contract data requirements list (CDRL) item approval rates, program briefings, integrated master schedule reviews, and budget materials, among other documents. We compared the program's progress with design and construction to leading practices that we identified for design in commercial shipbuilding.[1] We also reviewed the Navy's rationale and data used to certify that the frigate's basic and functional design were complete and supportive of the program's construction start, including Fincantieri Marinette Marine (FMM) production readiness briefings and Navy issued letters, among other documents. We interviewed officials from the Navy's FFG 62 program office; the FFG 62 Ship Design Manager within Naval Sea Systems Command (NAVSEA), Naval Systems Engineering and Logistics Directorate; Navy Supervisor of Shipbuilding, Conversion and Repair, and FMM representatives. We also conducted a site visit to FMM's facility, where FFG 62 is being constructed, to meet with FMM representatives and tour the shipyard.

To assess the extent to which the frigate program is meeting its construction progress goals, we identified and analyzed information related to both program cost and schedule. Specifically, we reviewed contract documents and key program schedule information, including ship contract delivery dates, integrated program management performance reports, NAVSEA integrated master schedule briefings, and other schedule information presented at gate reviews to Navy leadership.

To address technical uncertainties that pose risk to planned capabilities for frigates, we analyzed Fiscal Year 2024 President Budget Request materials to identify costly and mission-critical developmental systems planned to provide key capabilities to frigates. Based on this analysis, we

[1]GAO, *Navy Shipbuilding: Increased Use of Leading Design Practices Could Improve Timeliness of Deliveries*, GAO-24-105503 (Washington, D.C.: May 2, 2024); and *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009).

selected the following programs to include in the scope of this review: Enterprise Air Surveillance Radar (AN/SPY-6(V)3), Aegis Weapon System, Mk 41 Vertical Launch System, AN/SLQ-32(V)6 Electronic Warfare System, and Anti-Submarine Warfare Combat Suite. We also selected the Machinery Centralized Control System and Combined Diesel-Electric and Gas Turbine Propulsion system based on our review of shipbuilder documents.

We reviewed relevant documentation—such as development schedules and program briefings—and interviewed relevant officials to identify technical uncertainties, including developmental and integration risks, these systems pose to the frigate's planned capabilities. We also reviewed the Navy's plans for resolving technical uncertainties prior to the December 2026 lead ship delivery date.[2] We assessed (1) whether the system is fielded on other U.S. Navy ships, (2) whether the system will be tested on land prior to FFG 62 delivery, (3) whether the system will be operationally (fully) demonstrated on other U.S. Navy ship classes prior to FFG 62 delivery, and (4) other factors that reduce or increase system risk. We consider "operationally demonstrated" as fielding a system on an operational ship or conducting operational testing. Based on our assessment, we assigned a risk level—ranging from low to high—to each assessed system according to the following GAO-identified criteria:

1. Low risk—A fielded system with established form, fit, function that the Navy requires integration with FFG 62 prior to delivery.
2. Medium risk—A system that leverages prior or planned testing data from another U.S. Navy ship but requires limited new development plus integration to provide frigate capabilities prior to FFG 62 delivery.
3. High risk—A system that does not leverage prior or planned testing data from another U.S. Navy ship and requires significant new development plus integration to provide frigate capabilities prior to FFG 62 delivery.

To compare the differences between the propulsion systems planned for the Navy frigate and the system used on the Italian frigate, we analyzed Navy-provided information that included specifications on the individual propulsion system components for the Navy and Italian frigates. We reviewed the following propulsion system components: gas turbine,

[2]We used the frigate program's estimated December 2026 delivery date for this analysis, as it was the delivery date reported to Navy leadership.

electric propulsion motors, ship service diesel generators, main reduction gear, and propellor.

We also reviewed the frigate's June 2020 Test and Evaluation Master Plan and programmatic material related to the congressionally mandated Land Based Engineering Site. We interviewed relevant Navy and Office of the Secretary of Defense officials and contractor representatives responsible for developing, integrating, and testing these systems on the frigate. This included officials from the FFG 62 program office; Navy Program Executive Office for Integrated Warfare Systems; Naval Surface Warfare Center, Philadelphia Division; and Director, Operational Test and Evaluation. Lastly, we held site visits at the Land Based Engineering Site at Naval Surface Warfare Center Philadelphia and met with L3Harris representatives at the Machinery Centralized Control System Integration Laboratory.

To identify future opportunities to incorporate leading practices for product development within the frigate program, we reviewed the frigate's November 2022 acquisition strategy and compared it against our leading practices for product development.[3] Specifically, we analyzed the extent to which the Navy (1) structured the frigate program to capitalize on the innovation and schedule advantages afforded through iterative development cycles; and (2) incorporated other leading practices that propel these cycles, such as maintaining a sound business case, off-ramping capabilities that present a risk to schedule, collecting user feedback, and using iterative, agile methods centered on developing a minimum viable product. To assess the extent to which the frigate acquisition strategy aligned with our leading practices, we identified and searched for key terms that best represented a translation of terms from the leading principles of product development sub-principles into language in the acquisition strategy.

For each sub-principle, an analyst performed and documented a content analysis of the relevant text we identified in the acquisition strategy to assess whether it would be scored as fully implemented, partially implemented, or not implemented. This score was then independently reviewed by an analyst that was not involved in the development of the scores. We did not report the scores in the report, but we used the results

[3]GAO, *Leading Practices: Iterative Cycles Enable Rapid Delivery of Complex, Innovative Products,* GAO-23-106222 (Washington, D.C.: July 27, 2023), and *Leading Practices: Agency Acquisition Policies Could Better Implement Key Product Development Principles,* GAO-22-104513 (Washington, D.C.: Mar. 10, 2022).

of the analysis to identify leading principles the program implemented and areas of opportunity for improvement within the acquisition strategy. Additionally, we interviewed frigate program officials to seek their input on an initial draft of our leading practices analysis of the frigate acquisition strategy. We did not provide scores to the program office but, instead, summarized areas where we found the Navy fully or partially implemented our leading principles.

We conducted this performance audit from January 2023 to May 2024 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.

Appendix II: Leading Principles for Product Development

Figure 12: Leading Principles Applied During Iterative Cycles Used to Refine Knowledge

Leading principle	Associated sub-principles
 **Principle 1:** Attain a sound business case that is informed by research along with collaboration with users	1. Conduct market research to analyze whether customer and user demand exists or will exist for the product 2. Solicit input from anticipated customers and users of the product to identify the most important capabilities that the product will need to provide 3. Plan to allocate funding over time to the product development based on demonstrated progress, including achievement of phased schedule and performance goals 4. Preserve and rely on institutional memory and corporate knowledge to develop product cost and schedule estimates, avoid repeating earlier mistakes, and build on previous successes 5. Commit to product delivery and release dates only after collecting sufficient cost, schedule, and performance data needed to instill a high level of confidence that the product iteration can be developed and produced within budget 6. Employ and empower right-sized teams of multi-disciplined stakeholders that leadership has assessed as having the expertise and experience needed to develop the product 7. Terminate product development promptly if the product no longer has a sound business case
 **Principle 2:** Use an iterative design approach that results in minimum viable products	1. Use modern, digital design tools capable of integrating development of hardware and software 2. Apply Agile development methodologies to both hardware and software development 3. Implement iterative design and testing processes to generate a minimum viable product that can be continuously updated and improved after delivery
 **Principle 3:** Prioritize schedule by off-ramping capabilities when necessary	1. Implement periodic reviews with senior leadership to keep all stakeholders informed on the product development's progress 2. Maintain a realistic assessment of product development progress, with a willingness to make difficult decisions about capabilities 3. Off-ramp capabilities that present a risk to delivering the product on schedule
 **Principle 4:** Collect user feedback to inform improvements to the minimum viable product	1. Establish a process to facilitate active engagement with customers and users throughout the iterative development process and following product release 2. Use feedback from customers and users to identify desired improvements to the minimum viable product and inform plans for addressing those in the current and future product releases

Source: GAO analysis of company information; GAO (icons). | GAO-24-106546

Appendix III: Comments from the Department of the Navy

THE ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, DEVELOPMENT AND ACQUISITION)
1000 NAVY PENTAGON
WASHINGTON DC 20350-1000

MAY 15 2024

Ms. Shelby Oakley
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Ms. Oakley,

This is the Department of Defense response to the GAO Draft Report GAO-24-106546, "NAVY FRIGATE: Unstable Design Has Stalled Construction and Compromised Delivery Schedule," dated May 2024 (GAO Code 106546).

The Department appreciates the opportunity to comment on the draft report. Attached are technical comments and the responses to recommendations 1, 2, 3, 4, and 5. No sensitivity items were noted.

For further questions regarding this report, please contact CDR Katie Vasquez who can be reached at katherine.g.vasquez.mil@us.navy.mil and phone 703-614-5373.

Sincerely,

Nickolas H. Guertin

Attachments:
As stated

GAO DRAFT REPORT DATED MAY 2024
GAO-24-106546 (GAO CODE 106546)

"NAVY FRIGATE: UNSTABLE DESIGN HAS STALLED CONSTRUCTION AND COMPROMISED DELIVERY SCHEDULES"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommends that the Secretary of the Navy should ensure that the frigate program's functional design review practices and metrics be restructured to measure progress that reflects the quality rather than quantity of design deliveries received from the ship builder.
DoD RESPONSE: Concur. The Navy will ensure that the FFG program's design progress measurement incorporates the quality of the submitted design documentation.

RECOMMENDATION 2: The GAO recommends that the Secretary of the Navy should ensure that the restructured functional design review practices and metrics established under recommendation 1 be used to assess whether functional design is complete prior to beginning construction of the second frigate (FFG 63).
DoD RESPONSE: Concur, the Navy will make Functional Design completion an Exit Criteria for the Production Readiness Review for FFG-63.

RECOMMENDATION 3: The GAO recommends that the Secretary of the Navy should ensure that the detail design of any given grand module of lead and follow-on frigates be completed prior to beginning construction of that grand module, consistent with leading ship design practices.
DoD RESPONSE: Concur. The program will use the Module Readiness Review (MRR) process to conduct a risk assessment prior to beginning construction on grand modules on lead and follow-on FFGs. This assessment includes a detailed design completion assessment of the specific grand module.

RECOMMENDATION 4: The GAO recommends that the Secretary of the Navy, as part of the planned frigate Test and Evaluation Master Plan, should ensure that the plan incorporates additional land-based testing activities for the propulsion system and machinery centralized control system and schedules those activities on a timeline that realistically accounts for anticipated lead ship delivery delays.
DoD RESPONSE: Partially concur. The Navy will leverage early opportunities for additional risk reduction efforts during the program's test program as the LBES facility becomes available for use, targeting planned completion in FY29. Administratively, the Navy is not intending on updating the formal TEMP document with additional test objectives.

RECOMMENDATION 5: The GAO recommends the Secretary of the Navy, prior to acquiring an 11th frigate, should ensure that the Assistant Secretary of the Navy for Research, Development, and Acquisition review the frigate program's acquisition strategy to identify opportunities to incorporate leading practices for product development and update that strategy, as appropriate.
DoD RESPONSE: Concur.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Shelby S. Oakley, (202) 512-4841 or OakleyS@gao.gov

Staff Acknowledgments

In addition to the contact named above, Christopher R. Durbin (Assistant Director), Nathan Foster (Analyst in Charge), Breanne Cave, Lori Fields, Taylor Gauthier, Laura Greifner, Riley Knight, and Sylvia Schatz made key contributions to this report.

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