United States Government Accountability Office

Report to the Committee on Transportation and Infrastructure, House of Representatives

June 2023

COAST GUARD ACQUISITIONS

Offshore Patrol Cutter Program Needs to Mature Technology and Design

GAO-23-105805

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GAO Highlights

Highlights of GAO-23-105805, a report to the Committee on Transportation and Infrastructure, House of Representatives

Why GAO Did This Study

The Coast Guard plans to acquire a fleet of 25 OPCs—four ships in stage 1, 11 ships in stage 2, and 10 ships in a later effort—from at least two different shipbuilders. This is the component's highest investment priority. The OPCs will help ensure a variety of missions in offshore waters once the current fleet of aging MECs is decommissioned.

GAO was asked to review the OPC acquisition program's status and the Coast Guard's plans for the MECs. This report examines the extent to which (1) the OPC's design and construction practices are consistent with shipbuilding leading practices, (2) the OPC is meeting cost and schedule goals, and (3) a gap exists between the decommissioning of the MEC fleet and the deployment of the OPCs. GAO analyzed Coast Guard program documents and data, and interviewed Coast Guard officials and shipbuilder representatives.

What GAO Recommends

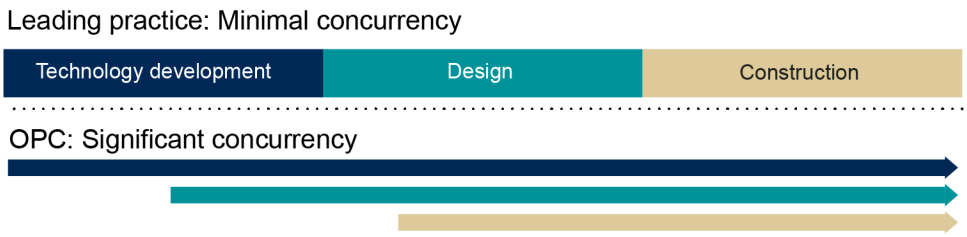
GAO continues to believe that its October 2020 recommendations have merit. GAO is making five new recommendations to the Coast Guard, including that it develop a technology maturation plan for the davit; demonstrate the davit in a realistic environment; and update its acquisition policy to require programs to complete routing of distributive systems as part of functional design prior to lead ship construction. DHS concurred with three of five recommendations, and did not concur with two. GAO has raised to the attention of Congress two matters for its consideration, as discussed in the report.

View GAO-23-105805. For more information, contact Marie A. Mak at (202) 512-4841 or makm@gao.gov.

What GAO Found

In October 2020, GAO found that the Offshore Patrol Cutter (OPC) program started construction on the lead ship with an unstable design. In this report, GAO found that the Coast Guard continues its approach of progressing through the technology development, design, and construction phases concurrently, which increases risk and is contrary to leading practices.

Offshore Patrol Cutter Program Continues Risky Approach of Overlapping Acquisition Phases



Source: GAO analysis of Coast Guard documentation. | GAO-23-105805

The Coast Guard has not developed a plan to mature the stage 1 OPC's critical technology—the davit (a crane that deploys and retrieves a cutter's small boats). Nor has the program integrated and demonstrated the davit in a realistic environment. Without a plan to mature the davit and demonstrate it before delivery, the Coast Guard risks further delays and costly rework.

In addition, the Coast Guard has not aligned its shipbuilding acquisition policy with shipbuilding leading practices. Specifically, the Coast Guard does not require completion of basic and functional design and maturity of all critical technologies, as GAO previously recommended. It also does not require completion of the design of distributive systems—systems that affect multiple zones of the ship—prior to construction of the lead ship. Significant rework can occur late in construction, resulting in subsequent cost growth and delays, if design of distributive systems are not completed prior to construction.

The OPC's total acquisition cost estimate increased from $12.5 billion to $17.6 billion between 2012 and 2022. The program attributes the 40 percent increase to many factors, including restructuring the stage 1 contract and recompeting the stage 2 requirement in response to a disruption caused by Hurricane Michael, and increased infrastructure costs for homeports and facilities, among other things. In addition, the program incurred a 1.5-year delay in the delivery of the first four OPCs due to Hurricane Michael and issues related to manufacturing the cutter's propulsion system. GAO also found indicators that the shipbuilder's significant level of complex, uncompleted work may lead to further delays.

Further, the Coast Guard faces an operational gap between the OPCs and the Medium Endurance Cutters (MEC), which the OPCs are replacing. This gap could worsen should the OPC program fall further behind schedule. All 28 MECs have exceeded their design service lives. The Coast Guard started a $1.86 billion acquisition program to extend the service life of six MECs, but the fleet faces risks of failure due to age and obsolescence.

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Abbreviations

ADE	acquisition decision event
C5ISR	Command, Control, Communication, Computer, Cyber, Intelligence, Surveillance, and Reconnaissance
CDR	critical design review
DHS	Department of Homeland Security
DOD	Department of Defense
ESG	Eastern Shipbuilding Group, Inc.
EVM	earned value management
FAR	Federal Acquisition Regulation
HVAC	heating, ventilation, and air conditioning
KPP	key performance parameter
MEC	Medium Endurance Cutter
NTNO	Navy-type Navy-owned
OPC	Offshore Patrol Cutter
PDR	preliminary design review
SCIF	sensitive compartmented information facility
SLEP	service life extension program
SOP	standard operating procedure
SPI	schedule performance index
TRL	technology readiness level

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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June 20, 2023

The Honorable Sam Graves
Chairman
The Honorable Rick Larsen
Ranking Member
Committee on Transportation and Infrastructure
House of Representatives

The Coast Guard—a component within the Department of Homeland Security (DHS)—plans to spend over $12 billion over a period of 20 years to acquire a fleet of 25 Offshore Patrol Cutters (OPC), an effort the Coast Guard calls its highest investment priority and largest acquisition program. The OPCs will replace the aging fleet of 28 Medium Endurance Cutters (MEC), which have exceeded their design service lives. The OPCs will enable the Coast Guard to continue conducting patrols for homeland security, law enforcement, and search and rescue operations.

In February 2014, the Coast Guard awarded contracts to three vendors for preliminary and contract design work for the OPC. Among these vendors, the Coast Guard selected Eastern Shipbuilding Group, Inc. (ESG) as OPC's shipbuilder by exercising ESG's contract option for detail design in September 2016 and an option for construction of the first OPC in September 2018. ESG is scheduled to deliver the lead ship in June 2023, but according to Coast Guard officials, this delivery date is no longer feasible. Following significant disruption caused by Hurricane Michael in October 2018, the Acting Secretary of Homeland Security determined that the OPC is essential to the national defense and authorized up to $659 million in extraordinary contractual relief to ESG pursuant to Public Law 85-804 for the design and construction of up to four OPCs, an effort the Coast Guard refers to as stage 1.[1] As part of this determination, the Acting Secretary also directed the Coast Guard to

[1]See Pub. L. No. 85-804 (codified as amended at 50 U.S.C. § 1431). Executive Order 10789, as amended by Executive Order 13286, implements and authorizes the Secretary of Homeland Security to use the authority. The extraordinary contractual authority authorizes the Secretary to modify contracts without regard to other provisions of law related to making, performing, amending, or modifying contracts, whenever such action would facilitate national defense.

recompete the requirement for the remaining 21 cutters.[2] In June 2022, the Coast Guard awarded a contract to Austal USA, LLC—hereafter referred to as Austal—for OPC detail design, with options for the construction of up to 11 OPCs, an effort known as stage 2.[3] The Coast Guard reported that the contract has a potential value of up to $3.3 billion if all options are exercised. On October 21, 2022, ESG filed a bid protest with the U.S. Court of Federal Claims, challenging the Coast Guard's award of the stage 2 OPC contract. At the time of this report, that litigation is pending. We are therefore not including an assessment of stage 2 in this report.

In October 2020, we found that the Coast Guard proceeded into construction with an incomplete design, increasing the risk of construction rework for the stage 1 OPCs.[4] Further, we noted that it would affect more OPCs if the program's level of design maturity continued to fall short of shipbuilding leading practices. Similarly, we reported that future Coast Guard shipbuilding programs, including stage 2 of the OPC program, would likely face cost and schedule risks from rework if the Coast Guard did not update its acquisition policy to align with leading practices on design and technology maturity. We made recommendations in this area, with which the Coast Guard concurred. Specifically, we made a recommendation that the Coast Guard update certain aspects of its acquisition policy to align with shipbuilding leading practices. The Coast Guard has not yet fully addressed this recommendation. We also recommended that the Coast Guard ensure the OPC program stabilizes

[2]For the purposes of this report, we use the agency's terminology of "recompete" to refer to the competitive award of new contracts for OPCs 5 through 25. ESG's contract originally included options for up to nine OPCs; OPCs 10 through 25 were to be acquired through a full and open competition.

[3]The Coast Guard plans to acquire OPCs 16 through 25 at a later date.

[4]GAO, *Coast Guard Acquisitions: Opportunities Exist to Reduce Risk for the Offshore Patrol Cutter Program*, GAO-21-9 (Washington, D.C.: Oct. 28, 2020).

its design and matures its critical technology prior to the start of construction on OPC 3.[5]

You asked us to review the status of the OPC acquisition program and the Coast Guard's plans for the MECs. This report examines the extent to which (1) the OPC program's design and construction practices are consistent with shipbuilding leading practices, (2) the OPC program is meeting its cost and schedule goals, and (3) a gap exists between the decommissioning of the MEC fleet and the deployment of the OPCs.

To address our objectives, we assessed documentation related to design and construction efforts on the OPC, such as design drawing completion rates, contract actions, and program briefings. We compared the OPC stage 1 design and construction practices to leading practices that we identified for design and construction in shipbuilding, and also leading practices for assessing technology readiness.[6] We also assessed documentation related to the program's cost and schedule, such as life-cycle cost estimates, the acquisition performance baseline, integrated master schedule, and earned value management data. We interviewed officials from the OPC program office, OPC project resident office that provides on-site oversight of ESG's ship construction, the Coast Guard's OPC ship design team, the Defense Contract Management Agency, the American Bureau of Shipping, the In-Service Vessel Sustainment program office—herein referred to as the MEC service life extension program (SLEP) office—, and the MEC Product Line, which is responsible

[5]In providing comments on this report, the Coast Guard concurred with our recommendation and stated that it would ensure the OPC design was stable and that the davit was matured to at least a technology readiness level (TRL) 7, or it would pursue a different davit before awarding OPC 3. However, in April 2021, the OPC program authorized construction on OPC 3 prior to completing the functional design and maturing the davit technology to a TRL 7. We therefore closed the recommendation as not implemented.

[6]Specifically, the shipbuilding leading practices identified in GAO, *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009); and GAO, *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP (Washington D.C.: June 6, 2018). We also used the technology readiness leading practices identified in 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).

for MEC maintenance.[7] We also conducted a site visit to two operational MECs, selected based on cutter availability in port and close proximity to the Coast Guard's maintenance yard, met with the Coast Guard crew and maintainers, and visited the yard that conducts the SLEP. We also conducted a site visit to the OPC stage 1 shipbuilder to tour the lead ship and shipyard, and met with representatives from ESG. Appendix I presents a detailed description of the objectives, scope, and methodology for our review.

We conducted this performance audit from February 2022 to June 2023 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

Coast Guard's Cutter Fleet

The Coast Guard operates a fleet of 28 MECs, consisting of 14 210-foot and 13 270-foot MECs, along with the 282-foot Alex Haley MEC (see fig. 1). Both classes of MECs are deployed for a wide range of mission operations, including search and rescue; interdicting illegal drugs and migrants; enforcing fishing laws; and securing ports, waterways, and coastal areas.

[7]The American Bureau of Shipping is a maritime classification society that develops rules defining a minimum level of technical standards that are applied to ships. It previously assisted the Navy in developing the Naval Vessel Rules, which establish a minimum set of requirements for the design and construction of the Navy's surface combatant ships. The OPC program adopted the Naval Vessel Rules with some modifications and requires the shipbuilder to obtain vessel classing from the American Bureau of Shipping in designing and building the OPC.

Figure 1: 210-foot and 270-foot Medium Endurance Cutters

U.S. Coast Guard 210-Foot Medium Endurance Cutter

U.S. Coast Guard 270-Foot Medium Endurance Cutter

Source: United States Coast Guard, Petty Officer 3rd Class Joshua Canup, and United States Coast Guard District 1. | GAO-23-105805

Due to their age, the condition of the MECs has diminished and they are facing increasing obsolescence. The average ages of the 210-foot MECs and 270-foot MECs are approximately 56 and 36 years old, respectively, and they were originally planned to have a service life of 30 years. For many of the MECs' systems, the original manufacturer no longer makes replacement parts, including for key systems such as the generators, fire pumps, and other auxiliary equipment. To help sustain the MECs, the Coast Guard conducted three major recapitalization and maintenance efforts between 1987 and 2014. However, in July 2012, we reported that the MECs were expensive to maintain and prone to failures, which hindered their operational capacity to meet mission requirements.[8] We also reported in 2012 that the Coast Guard was facing an operational capability gap as the service life of the MECs was estimated to end before the upgraded and more capable OPCs were originally scheduled to be delivered starting in 2020.

In July 2018, we found that maintaining the MECs continued to be a challenge due to age and obsolescence.[9] At that time, to address the risk of an operational capability gap until the OPCs could join the fleet, the

[8]GAO, *Coast Guard: Legacy Vessels' Declining Conditions Reinforce Need for More Realistic Operational Targets,* GAO-12-741 (Washington, D.C.: July 31, 2012).

[9]GAO, *Coast Guard Acquisitions: Actions Needed to Address Longstanding Portfolio Management Challenges,* GAO-18-454 (Washington, D.C.: July 24, 2018).

Coast Guard planned to conduct a SLEP—a program to extend the service lives of the 270-foot MECs. But the Coast Guard had not determined how many of the 13 cutters would undergo the SLEP. According to officials at the time, the Coast Guard developed a business case that did not support having an equivalent SLEP plan for the 210-foot MECs. We noted in 2018 that all of the 210-foot MECs and possibly some of the 270-foot MECs would need to operate well past their original service lives until they were replaced.

In January 2008, the Coast Guard established the OPC program's mission needs. These generally include the same range of mission operations as the MECs, including search and rescue and interdicting drugs and migrants. Designed for long-distance transit, extended on-scene presence, and operations with deployable aircraft and small boats, the OPCs are intended to provide the majority of offshore presence for the Coast Guard's cutter fleet.[10] The OPCs were intended to bridge the operational capability gap between the National Security Cutters, which patrol the open ocean, and the Fast Response Cutters, which serve closer to shore. Figure 2 is a photograph of the first OPC under construction at the shipbuilder's yard.

[10]The Coast Guard refers to the boats that operate from cutters as "cutter boats," but for the purposes of this review we use the term "small boats" to distinguish them from the Coast Guard's fleets of cutters.

Figure 2: Photograph of the Offshore Patrol Cutter

Source: Eastern Shipbuilding Group. | GAO-23-105805

Cutter Capabilities and Major Systems

The Coast Guard established key performance parameters (KPP) that the OPC must meet to achieve full operational capability. Some examples of KPPs are the ability to handle at least 45 days at sea while housing a crew of 104, and the capability of launching small boats and helicopters for operations such as drug and migrant interdiction, search and rescue, and law enforcement activities. Table 1 details examples of key characteristics of the MEC fleet and the OPC.

Table 1: Examples of Key Characteristics of the Medium Endurance Cutters (MEC) and Offshore Patrol Cutter (OPC)

Key characteristic	210-foot MEC	270-foot MEC	OPC
Operating range	6,100 NM	8,500 NM	8,500 NM
Crew size	77	100	104
Small boat/Helicopter ops/ Rescue assist sea keeping[a]	Sea State 5	Sea State 4	Sea State 5
Survivability sea keeping[a]	N/A	N/A	Sea State 8
Patrol endurance	21 days underway	21 days underway	45 days underway

Source: GAO presentation of Coast Guard information. | GAO-23-105805

[a]Sea keeping is the ability of the vessel to withstand varying conditions at sea. Sea state refers to the height, period, and character of waves—ranked 0 to 8, from calm to very high—on the surface of a large body of water. Sea state 4 is moderate at 4-to-8-foot waves, sea state 5 is rough at 8-to-13-foot waves, sea state 7 is high at 20-to-30-foot waves, and sea state 8 is very high at 30-to-46-foot waves.

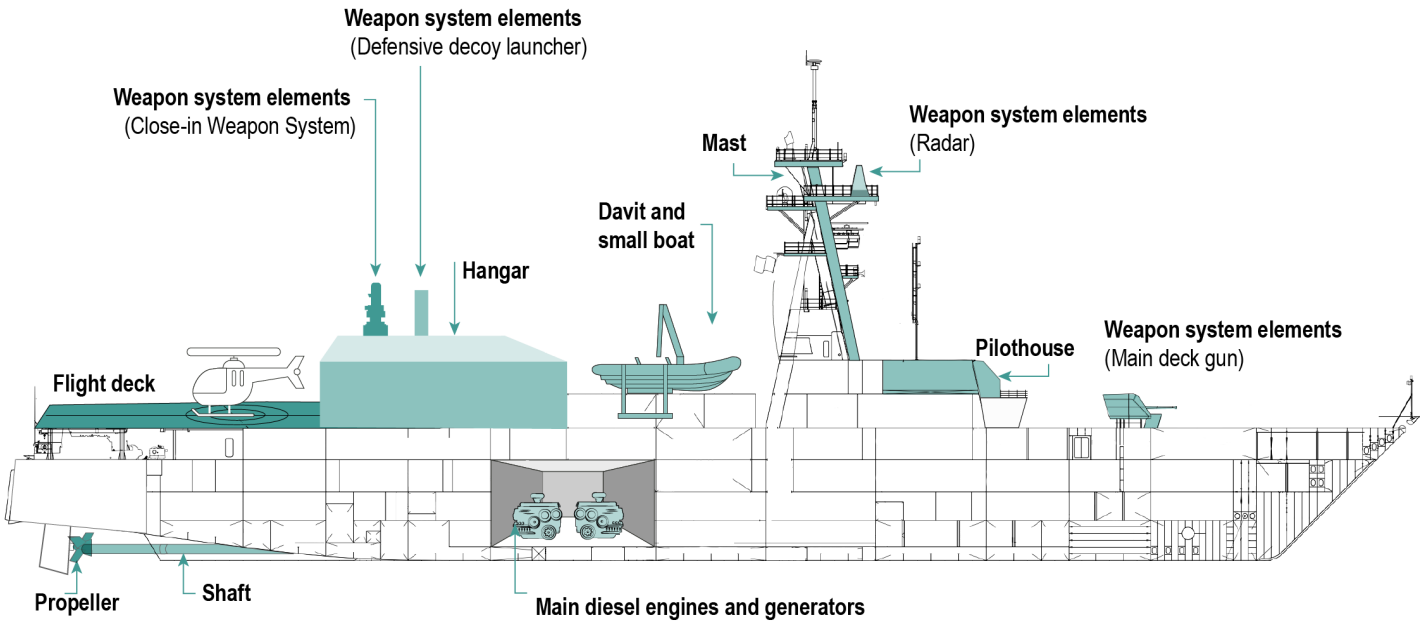
The OPC and MEC have key components and equipment that enable the cutters to perform their various missions. The key components and equipment include:

- **Main diesel engines.** Main diesel engines provide the power for propulsion of the cutter. The OPC will feature two main propulsion diesel engines. MECs entering SLEP will receive remanufactured engines to replace obsolete ones.
- **Electrical plant.** Power onboard the MEC and OPC is provided via ship diesel generators. Switchboards connect the ship's power generators to the ship's electrical system including power panels and transformers. MECs entering SLEP will receive electrical system upgrades to both power generators and switchboards.
- **Weapon systems.** Weapon systems provide defensive capabilities used in some operations. Both the OPC and MEC (following SLEP upgrades) will feature Navy-type Navy-owned (NTNO) weapon and radar systems. During SLEP, MECs will receive a weapon system interchange to replace their obsolete MK-75 gun.
- **Flight deck and hangar.** Some Coast Guard cutters can employ and house helicopters for various mission capabilities such as drug and migrant interdiction, search and rescue, and law enforcement activities. The OPC is designed to hangar and operate one H-60 or H-65 helicopter at a given time. The flight deck and hangar on the 270-foot MEC is smaller, and therefore is only able to employ and maintain one H-65 helicopter, which is dimensionally smaller than the H-60. The 210-foot MEC has a flight deck that can support an H-65, but does not have a hangar.

- **Pilothouse.** The pilothouse on the MEC and OPC holds major navigational equipment, as well as throttle and electrical propulsion controls. The pilothouse also holds major communication equipment and aircraft control systems.
- **Propulsion system.** The propulsion systems on the MEC and OPC include propellers and shafts, among other things. The propeller is the mechanism used to generate thrust to move a ship or boat through the water. The shaft directs the power generated by the engine to the propellers, which then provides thrust for the vessel.
- **Davit and small boats.** The davit is a crane responsible for deploying and retrieving the cutter's small boats (also referred to as Over the Horizon boats) from their carrying position on the deck of the cutter. It is therefore a key enabling technology that allows crews to carry out mission operations. The Coast Guard identified the davit as a critical technology element for the upcoming OPC. The davit technology is novel in that the dual-point electric motor system is integrated with constant tensioning, for which the functionality has not been demonstrated. Other cutters in the Coast Guard fleet—including the MECs—use davits with a hydraulic motor system. According to the OPC program's KPPs, the davit must be capable of launching and recovering small boats in sea state 5, which refers to rough conditions with 8-to-13-foot waves.

Figure 3 depicts selected systems and notional locations on Coast Guard cutters.

Figure 3: Notional Graphic of Major Systems on Coast Guard Cutters



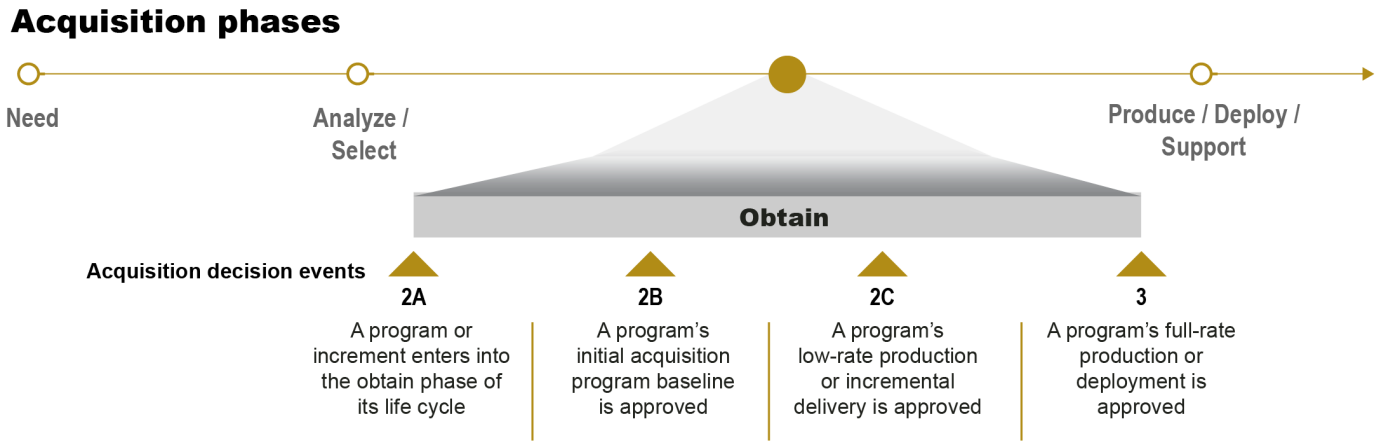
Source: GAO presentation and analysis of U.S. Coast Guard data; GAO (icons). | GAO-23-105805

OPC Program's Acquisition Life-Cycle Framework and History

The Coast Guard manages and oversees the OPC program using DHS's acquisition life-cycle framework.[11] DHS's acquisition policy establishes that a major acquisition program's decision authority shall review the program at a series of predetermined acquisition decision events (ADE) to assess whether the major program is ready to proceed through the acquisition life-cycle phases (see fig. 4).

[11]As a component within DHS, the Coast Guard is required to follow DHS's acquisition policies. Some DHS guidance is broad and allows programs to tailor requirements as needed.

Figure 4: Overview of the DHS Acquisition Life-Cycle Framework for Major Acquisition Programs



Source: GAO analysis of Department of Homeland Security (DHS) documents. | GAO-23-105805

The DHS Under Secretary for Management has final decision authority for the OPC's ADEs as the acquisition decision authority, while the Vice Commandant of the Coast Guard serves as the component acquisition executive, or the senior acquisition official within the Coast Guard.

DHS acquisition policy establishes that the acquisition program baseline is the fundamental agreement between program, component, and department-level officials establishing what should be delivered, how it should perform, when it should be delivered, and what it should cost. Specifically, the program baseline establishes a program's schedule, costs, and KPPs, and covers the entire scope of the program's life cycle. The acquisition program baseline establishes objective (target) and threshold (maximum acceptable for cost, latest acceptable for schedule, and minimum or maximum acceptable for performance) baselines. According to DHS policy, if a program fails to meet any schedule, cost, or performance threshold approved in the acquisition program baseline, it is considered to be in breach. Programs in breach status are required to notify their acquisition decision authority and (1) develop a remediation plan that outlines a time frame for the program to return to its acquisition program baseline parameters, (2) rebaseline—that is, establish new schedule, cost, or performance goals—or (3) have a DHS-led program review that results in recommendations for a revised baseline.

Within the acquisition life cycle, the program is responsible for design maturity during all phases of design. According to leading practices we identified for shipbuilding, design stability is achieved upon completion of the basic and functional ship designs.[12] Coast Guard officials said they use Navy practices as a foundation for their acquisition programs. Ship design is an iterative process, with the fidelity of design drawings increasing as the process progresses. Table 2 describes the design phases that typically comprise the development of preliminary and detail design in major shipbuilding programs and the Coast Guard's equivalent terminology. Table 2 also includes Department of Defense (DOD) terminology since the Navy manages a significant number of shipbuilding programs.

[12]GAO-09-322.

Table 2: General Shipbuilding Design Phases

Design phase		Coast Guard terminology	Description
Preliminary design[a]	Basic design	Preliminary and contract design	Preliminary and contract design includes establishing the hull form, general arrangements of compartments, and outlining significant ship steel structure. Some routing of major equipment and related major distributive systems, including electricity, water, and other utilities is done. It also ensures the ship will meet the performance specifications, informs overall ship cost, facilitates shipbuilders' development of responsive proposals, and identifies major equipment and components that must be purchased in advance.
	Functional design	Functional and transitional design	Functional design includes providing a further iteration of the basic design, such as size and positioning of structural components, information on the positioning of major piping and other distributive systems and outfitting in each block—or basic building unit for a ship. Transitional design is an iteration of functional design where the specific locations of equipment, components, and distributive systems are further refined. For programs that use computer design tools, transitional design is when 2D design drawings are turned into a 3D design model. Department of Homeland Security (DHS) policy generally requires programs to conduct a preliminary design review to ensure that the planned technical approach meets requirements. A program's preliminary design review occurs prior to acquisition decision event (ADE) 2B. Department of Defense (DOD) policy generally requires major defense acquisition programs to conduct a preliminary design review to demonstrate that the preliminary design and basic system architecture are complete, and that there is technical confidence that the capability need can be satisfied within cost and schedule goals, prior to moving to detail design.
Detail design	Production design	Production design	Production design includes generating work instructions that show detailed system information and also guidance for subcontractors and suppliers needed to support construction, including installation drawings, schedules, material lists, and lists of prefabricated materials and parts. As part of this, the shipyard requires final technical data for key components prior to developing the work instructions. DHS policy generally requires acquisition programs to conduct a critical design review to assess whether the system's detailed design meets requirements. However, a DHS official said that programs generally conduct the review to assess whether the system's functional design meets requirements. A program's critical design review occurs prior to its production readiness review and ADE 2C, which approves production. DOD policy generally requires major defense acquisition programs to conduct a critical design review prior to proceeding with production. Before production begins, these DOD programs generally also hold a production readiness review, which validates that the system design is ready for production and there is a sufficiently mature manufacturing process. In addition, leading practices for shipbuilding state that critical technologies should be successfully demonstrated in a realistic environment prior to the award of the contract for the lead ship design.

Source: GAO presentation of DHS, Coast Guard, and DOD information, and information from GAO-09-322. | GAO-23-105805

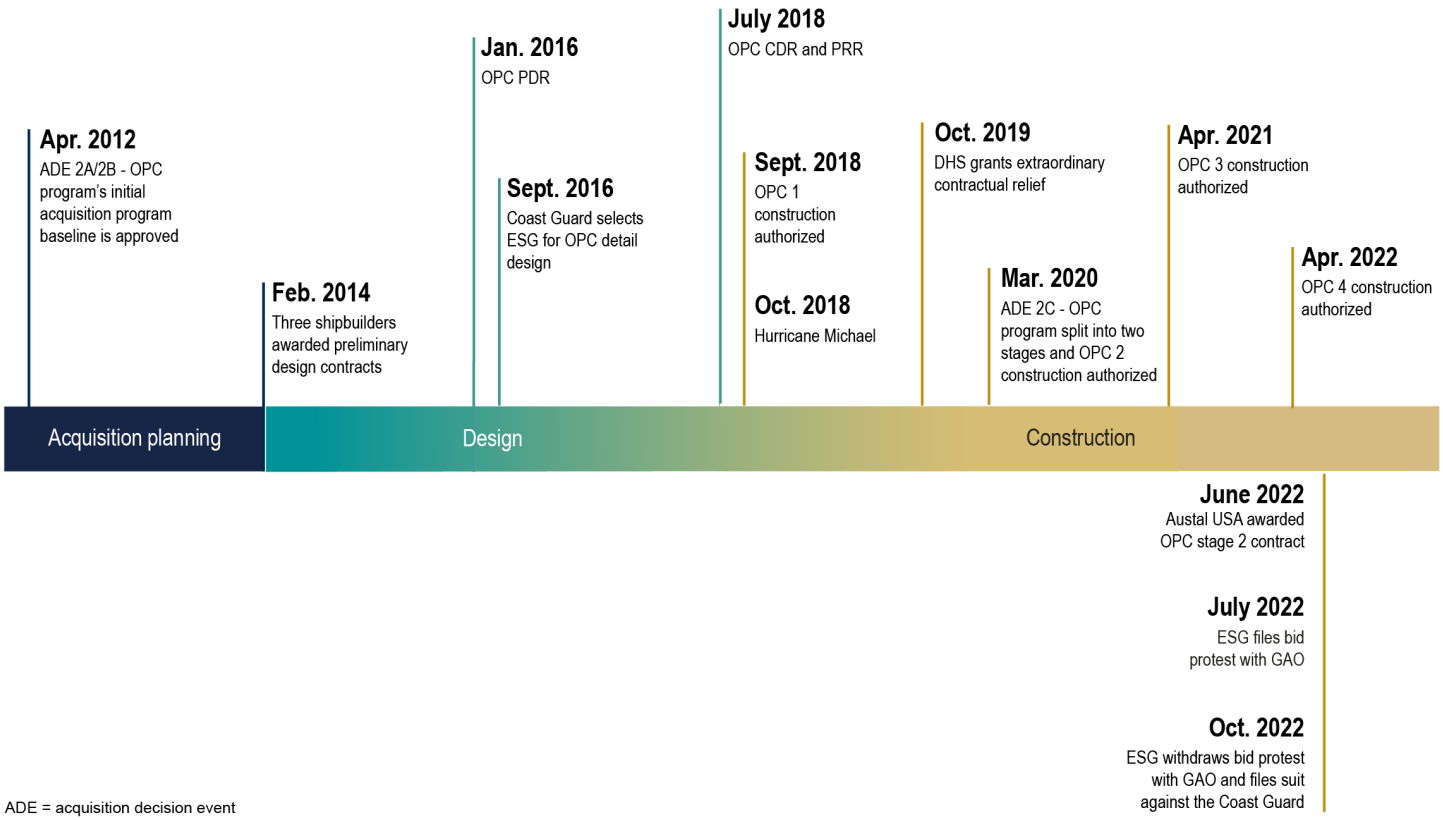
Note: The table reflects definitions of design phases based on our shipbuilding leading practices, as well as acquisition events for both DHS and DOD, given that the Navy also has shipbuilding programs. We compiled this table with input from the Coast Guard, but specific definitions may vary

depending on the program. We previously determined that the Coast Guard's design terminology definitions—along with their associated outputs—generally align with our definitions. See GAO-21-9.

[a]For the purposes of this report, we refer to the activities that include basic and functional design as preliminary design.

Figure 5 provides an overview of design reviews and other selected key events for the OPC program from April 2012, when the program achieved ADE 2A/2B, through October 2022.

Figure 5: Selected Major Offshore Patrol Cutter (OPC) Acquisition Milestones and Related Events from April 2012 through October 2022



ADE = acquisition decision event
CDR = critical design review
DHS = Department of Homeland Security
ESG = Eastern Shipbuilding Group
OPC = Offshore Patrol Cutter
PDR = preliminary design review
PRR = production readiness review

Source: GAO analysis of U.S. Coast Guard information. | GAO-23-105805

Additional details on selected recent OPC events are outlined below:

- On June 30, 2022, Coast Guard awarded Austal the detail design and construction contract for stage 2 of the OPC acquisition. Austal's contract includes options for OPCs 5-15.
- On July 15, 2022, ESG filed a bid protest with GAO challenging the award to Austal of the stage 2 OPC contract.
- On October 4, 2022, ESG withdrew its bid protest with GAO. On October 21, 2022, it filed a bid protest against the Coast Guard with the U.S. Court of Federal Claims, again challenging the Coast Guard's award of the stage 2 OPC contract. Litigation is pending, and in the meantime, Austal is proceeding with design work. Pending the outcome of this litigation, we are not including an assessment of stage 2 in this report.

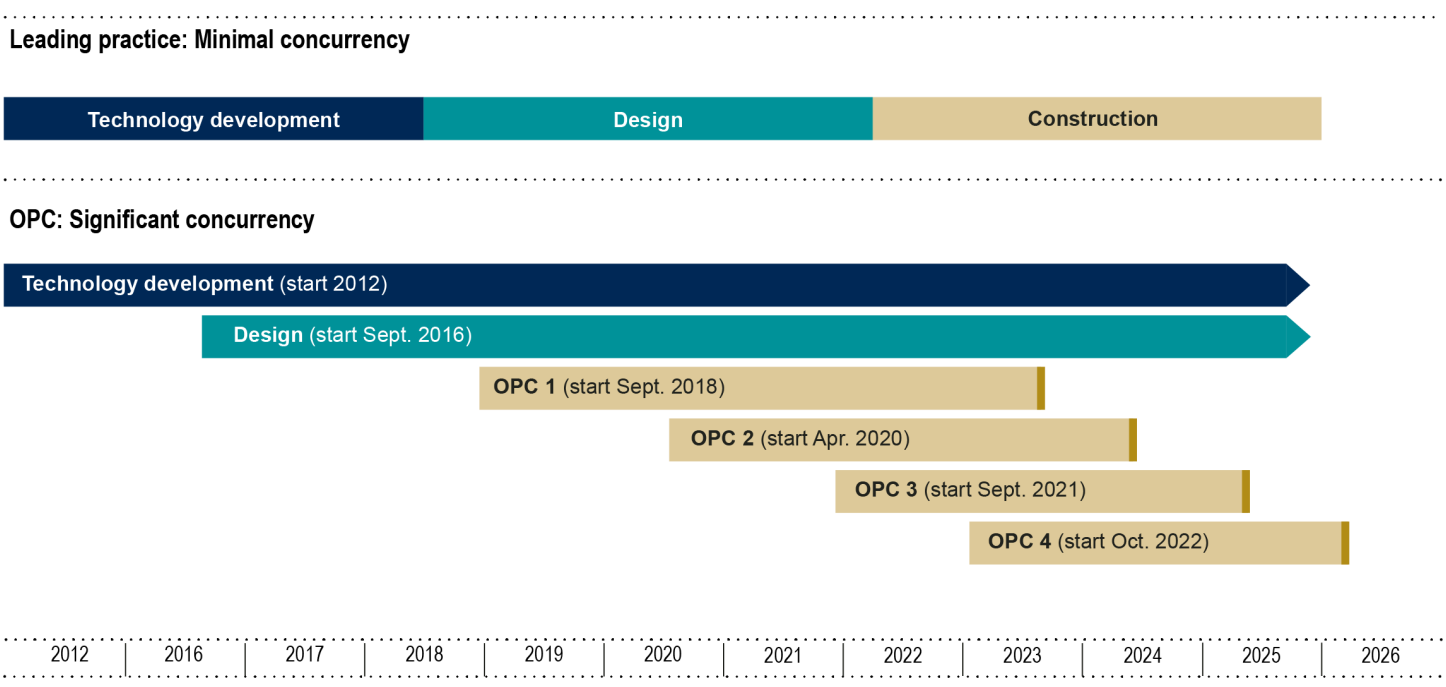
Program Pursued Higher-Risk Concurrent Approach of Maturing Critical Technology during Ship Design and Construction

Overlap Exists Between Technology Development, Design, and Construction

The Coast Guard continues to employ a higher-risk, concurrent approach to its OPC stage 1 shipbuilding program that we noted in prior work and that is inconsistent with shipbuilding leading practices. In October 2020, we reported that under this approach, the Coast Guard proceeded into construction of the first two stage 1 ships without first maturing its critical technology or achieving a stable design.[13] Since then, the Coast Guard began construction of OPCs 3 and 4, again without maturing its critical technology or achieving a stable design. The shipbuilding leading practice is to sequentially move through the three main phases of the shipbuilding process with minimal concurrency. The OPC stage 1 program, however, has had significant overlap between all three phases (see fig. 6).

[13]GAO-21-9.

Figure 6: Offshore Patrol Cutter (OPC) Program Continues Risky Approach of Overlapping Acquisition Phases



Source: GAO analysis of U.S. Coast Guard documentation. | GAO-23-105805

Note: While some overlap between the design and construction phases is normal, the OPC program has significant overlap between all three phases. The OPC's design phase in this figure refers to the detail design effort that began after the Coast Guard exercised Eastern Shipbuilding Group's contract option for detail design in September 2016.

We previously found that, in general, concurrency or overlap between the technology development, design, and construction phases of shipbuilding typically results in poor acquisition outcomes, including cost growth and schedule delays that disrupt multiple ships in the class.[14] The OPC program has started to realize similar negative cost and schedule effects. For example, in the 23-month period from January 2021 to December 2022, the program's estimated cost for stage 1 detail design increased by 6 percent and the estimated cost for lead ship construction increased by 19 percent.

[14]GAO-18-238SP.

Program Has Not Taken Steps to Ensure Maturity of Davit Technology

Use of Davit in Sea State 5

In 2010, the Coast Guard determined that sea state 5 small boat operations were a critical and essential characteristic for its medium-range security cutters. The study, which formed the basis of the Offshore Patrol Cutter's (OPC) key performance parameters, found that nine of the Coast Guard's 14 operating areas had an average sea state of 5 or greater for at least 50 percent of the year. According to the Coast Guard, there is currently no davit on the market that can launch and recover small boats in sea state 5. Both the 210-foot and 270-foot Medium Endurance Cutters can conduct small boat operations in conditions up to sea state 4, meaning operations are unsafe in a significant percent of key operating areas. A davit that meets the contract specification for small boat operations in sea state 5 will enable the OPCs to conduct these operations more routinely and frequently in assigned operational areas.

Source: Review of Coast Guard documentation and interviews with officials. | GAO-23-105805

The Coast Guard did not take steps to reduce risk for or prioritize maturity of the davit—the OPC's only critical technology—prior to the start of construction of the lead ship.[15] The program has not mitigated the cost, schedule, and capability risk posed by this immature technology.

Coast Guard officials told us that when they selected ESG to proceed with OPC detail design in September 2016, they intended the OPC to be "state of the market," meaning that it would incorporate no new or developmental technologies. At that time, ESG selected a vendor and davit design that it believed would achieve the OPC performance requirement of rescue and small boat operations in sea state 5 by making modifications to a preexisting hydraulic davit.[16]

However, in December 2017 and almost 2 years following the preliminary design review, ESG informed the OPC program that it had switched to a new davit subcontractor. This company, Palfinger, proposed a novel davit design using an electric motor instead of hydraulics, which, according to Coast Guard officials, would require new integration of existing technologies to meet the Coast Guard's specifications for small boat operations in sea state 5. Coast Guard officials said that while electric davits and constant tensioning systems used to lower a boat safely to the water are currently in use on commercial vessels, the integration of electric motors with a constant tensioning system with the higher spooling speeds to control the cabling is new. According to the Coast Guard, no such davit existed on the market at that time that could meet the OPC performance requirement for small boat operations in sea state 5. In July 2018 at the OPC critical design review, which precedes the program's production readiness review that assesses the program's readiness to start construction, the Coast Guard identified technology readiness as a moderate risk since the davit design involved risky technology, and the time frames for testing constituted a schedule risk for OPC 1. However, the Coast Guard authorized ESG to begin OPC 1 production soon after. A Coast Guard official said that the program developed a business case at that time that showed holding up construction for a davit design was a significantly more expensive alternative. Yet, according to our prior work,

[15]A technology element is considered a critical technology if it is new or novel, or used in a new or novel way, and it is needed for a system to meet its operational performance requirements within defined cost and schedule parameters. The OPC's davit system is an enabler of mission capabilities and tied to key performance requirements.

[16]Sea state refers to the height, period, and character of waves on the surface of a large body of water. Sea state 5 is characterized as rough, with waves ranging from 8 to 13 feet.

programs that begin construction with immature critical technologies undemonstrated in a realistic environment are at greater risk of cost growth and schedule delays.[17]

In the over 5 years since its selection of the electric Palfinger davit, ESG and its subcontractor have encountered repeated design and manufacturing challenges in maturing this critical technology. After identifying issues during developmental testing, Palfinger has repeatedly redesigned the davit and developed new manufacturing approaches. This in turn has led to delays in the Coast Guard approving the davit's design, and in both the davit's component acceptance testing and first article testing of the integrated davit system.[18] In an October 2022 Coast Guard memorandum, the OPC ship design team outlined multiple high-risk and ongoing design issues for the davit:

1. **Rack and pinion luff system.** The rack and pinion luff system—which enables the davit to raise and lower the small boats using a crane-like arm—encountered two issues in developmental testing in November 2021 and in September 2022 that required redesign and remanufacture on multiple occasions. The Coast Guard has since approved the redesign, but the system is awaiting manufacturer completion and demonstration through testing.
2. **Electrical cabinet design change.** Coast Guard officials told us the design provided by Palfinger in summer 2021 for the electrical cabinet, which houses the equipment to power the davit, did not fit the specifications provided by ESG and the Coast Guard. Specifically, the electrical cabinet was too large to fit into its allocated interior space and was therefore split into multiple electrical components, one of which were moved to the OPC's weather deck (outside of the deckhouse and exposed to the elements). Because of this change, according to Coast Guard officials, Palfinger must prove the electrical components it selected will successfully work in all required environmental constraints of the ship, including extreme weather considerations. Palfinger has provided two series of the electrical cabinet calculations and drawings, both of which were rejected by ESG for not meeting requirements. As of March 2023, Palfinger has

[17]GAO-20-48G.

[18]First article testing means testing and evaluating the first article (or the preproduction or pilot model) for conformance with specified contract requirements before or in the initial stage of production. Federal Acquisition Regulation (FAR) 2.101. First article testing and approval ensures that the contractor can furnish a product that conforms to all contract requirements for acceptance. FAR 9.302.

not yet provided the third iteration. Coast Guard officials report that following ESG approval, these calculations must also be approved by the American Bureau of Shipping and the Coast Guard.

3. **Drive train component selection.** As of October 2022, the Coast Guard identified that a number of brakes and clutches selected for use in the Palfinger davit's drive train did not meet the contract's specifications, and in some cases these components were not designed for appropriate applications or conditions. For example, the contract requires that deck machinery and equipment components are capable of operating in conditions ranging from -20°F to 140°F and up to 100 percent humidity. One of the selected holding brakes, however, is designed for a temperature range of -13°F to 104°F and in dry environments only. The friction material used in these brakes can swell when wet, experience accelerated wear, and slip in damp conditions, leading to safety concerns. The Coast Guard identified similar concerns with at least four other selected components. Program officials told us in March 2023 that Palfinger had recently made progress in addressing most of these issues by upgrading its material selections to marine-grade. However, these same officials also identified additional risks with the drive train that have not yet been resolved.

Six times since July 2018, the Coast Guard has sent what it refers to as "letters of concern" to ESG related to poor performance in developing the davit, most recently in March 2022.[19] However, Coast Guard officials said that they not yet taken any further contractual action, but that they continue to require that contract data requirements are submitted and reviewed. Coast Guard officials told us that ESG's progress toward delivery of a davit that meets the contract specification will inform any further action. Depending on the severity of the issue, agencies have a spectrum of options to address contractor performance issues.

Since ESG switched to the novel Palfinger davit design in 2017, the Coast Guard has not taken additional steps to ensure the maturity of the new davit design. For example, the OPC program did not revisit its preliminary design review upon selection of the new davit design. The Coast Guard also approved OPC's critical design review and determined the design was sufficiently mature to proceed with the next step toward production in 2018, even though the program had yet to conduct an

[19]Coast Guard officials said that letters of concern are a tool used by Coast Guard contracting officers to express dissatisfaction or concern to a contractor about its performance under a contract.

independent assessment of the technology and knew the davit was in early stages of development. In addition, the Coast Guard did not follow technology development leading practices at the point of this decision nor when the program identified the davit as a critical technology in a 2020 technology readiness assessment.[20] These leading practices include, but are not limited to:

1. **Develop a technology maturation plan.** The Coast Guard has not developed a technology maturation plan—a management planning tool for critical technologies assessed as immature—since it identified the davit as an immature critical technology in 2020. We previously found that technology maturation plans are effective in helping programs achieve technology maturity when the plan establishes a road map with the necessary activities to achieve that end.[21] The plan should also identify technology alternatives and the off-ramps that the program would take if results are less than required at each critical decision milestone. We also found that as estimates breach established thresholds, such as those for schedule or performance in this case, programs should immediately reassess a project to determine whether it is still relevant and affordable.[22] As part of this reassessment, programs should continually make go/no-go decisions to shape strategic outcomes.

   Given the challenges the contractor and subcontractor have faced in maturing the davit, program officials said they are currently considering contingencies they can pursue if the technology does not mature in time for operations. For example, to give the shipbuilder additional time to develop the davit should it not be ready by lead ship acceptance, the Coast Guard officials told us they could potentially install a legacy davit system post-delivery. This would enable the cutter to perform the basic function of launching and recovering a small boat, though not in sea state 5, as identified in the stage 1

[20]A technology readiness assessment is a systematic, evidence-based process that evaluates the maturity of technologies (hardware, software, and processes) critical to the performance of a larger system or the fulfillment of the key objectives of an acquisition program, including cost and schedule. Technology readiness assessments, which evaluate the technical maturity of a technology at a specific point in time for inclusion into a larger system, do not eliminate technology risk. But when done well, they can illuminate concerns and serve as the basis for realistic discussions on how to address potential risks as programs move from the early research and technology development to system development and beyond.

[21]GAO-20-48G.

[22]GAO, *Coast Guard: Portfolio Management Approach Needed to Improve Major Acquisition Outcomes*, GAO-12-918 (Washington, D.C.: Sept. 20, 2012).

contract specification. In this scenario, ESG would still be responsible for delivering the contractually compliant davit for all stage 1 ships, but would have more time to develop it.

Although the program is considering contingencies for the Palfinger davit, officials told us that they do not have a formal technology maturation plan. OPC program officials told us that they do not want to expend substantial effort in developing contingencies because it is their expectation that ESG will eventually meet the performance requirement. However, given the continued technical challenges and that Coast Guard officials told us that the davit has not matured beyond a technology concept—where components of the technology are neither representative nor integrated—as of February 2023, it is unlikely that ESG will have a davit that meets the contract specifications by the current OPC 1 contractual delivery date of June 2023.

2. **Test integrated prototype in realistic environment.** The Coast Guard conducted a technology readiness assessment in 2020 that determined certain elements of the davit to be at a technology readiness level (TRL) 2, or the equivalent of a technology concept.[23] A TRL is a measurement of maturity for each critical technology, numbered 1 through 9 from least to most mature based on demonstrations of increasing fidelity and complexity. See table 3 for descriptions of the TRLs in accordance with DHS guidance, with examples from our prior work.[24]

[23]A technology concept is described as when invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions.

[24]DHS, *Systems Engineering Life Cycle Guidebook* (May 2021).

Table 3: Technology Readiness Levels (TRL)

TRL	Description	Example
1	Basic principles observed and reported	Paper studies of a technology's basic properties
2	Technology concept and/or application formulated	Analytic studies
3	Analytical and experimental critical function and/or characteristic proof of concept	Components that are not yet integrated or representative
4	Component and/or breadboard validation in laboratory environment	Integration of ad hoc hardware in a laboratory
5	Component and/or breadboard validation in relevant environment	High fidelity laboratory integration of components
6	System/subsystem model or prototype demonstration in an relevant environment	Prototype testing in a high-fidelity laboratory environment or in a simulated operational environment
7	System prototype demonstration in an operational—or realistic—environment	Prototype testing on the planned environment, such as in an aircraft, vehicle or space
8	Actual system completed and qualified through test and demonstration	Developmental test and evaluation of a system in its intended weapon system to determine it meets design specifications
9	Actual system proven through successful mission operations	Using the system under operational mission conditions.

Source: GAO presentation of information from DHS guidance and GAO-20-48G. | GAO-23-105805

The shipyard started construction of the lead ship in September 2018 while the davit was still immature. The davit has yet to undergo the first article test, when the product is tested and evaluated for conformance with contract requirements before production. Shipbuilding leading practices state that programs should mature critical technologies to a TRL 7—demonstrating an integrated prototype successfully in a realistic environment—prior to contract award for detail design of a new ship.[25]

In October 2020, we recommended that the Commandant of the Coast Guard ensure the OPC program demonstrates that the OPC design is stable, including maturing the davit to a TRL 7, prior to construction start for OPC 3. The Coast Guard concurred with the recommendation, but in April 2021 the OPC program authorized construction on OPC 3 without achieving design or technology maturity. Consequently, we closed this recommendation as not implemented.

Program officials now state that a TRL 7—while desirable—cannot be demonstrated until the ship faces the operational environment that will

[25]GAO-09-322.

be presented at builder's trials and acceptance trials.[26] However, this more accurately represents a TRL 8 test environment. We maintain that testing the integrated davit in at least a realistic environment (TRL 7) prior to builder's trials is feasible since a realistic environment means testing the davit in an at-sea environment—and not necessarily on a crewed OPC. It also does not have to be under all operational conditions, such as a sea state 5. This type of testing would give the program important information about the level of maturity of the system prior to government acceptance. Coast Guard officials told us in March 2023 that they plan to conduct integration testing of the Palfinger davit on an actual OPC ahead of builder's trials and acceptance trials. However, if there are further delays to integration and testing of the davit, the window of time that the program would have to address any issues that are identified would be compressed.

For stage 2, program officials told us the shipbuilder plans to use all-electric davits designed by a subcontractor other than Palfinger, which they explained will require development to meet the OPC specifications. Without ensuring these davits, and any other stage 2 critical technology elements, are matured to a TRL 7 before preliminary design review—which is the next milestone for the program, and the Coast Guard already awarded the contract for detail design and construction—the OPC stage 2 risks delays in finalizing a davit design and not meeting performance requirements.

Without developing a technology maturation plan, including evaluating all courses of action that could address Palfinger's delays and potential inability to reach technology maturity of its davit and establishing a go/no-go decision point, the Coast Guard risks having a davit that does not meet the fleet's performance requirements. Further, the Coast Guard's lack of a technology maturation plan prevents it from minimizing additional schedule risk to the program should maturation continue to stall. It also risks additional cost increases if the Coast Guard decides to equip OPCs with legacy davits as an interim measure, since our previous work shows that retrofitting ships post-delivery can be expensive. In addition, if the program does not ensure the davit meets a TRL 7 by builder's trials, the Coast Guard risks potential cost increases and schedule delays should it find problems during trials that require design changes and subsequent retrofitting that would need to be done later.

[26]Builder's trials and acceptance trials are events meant to test and evaluate a ship's performance. Builder's trials are conducted by the contractor and determine whether the ship is ready for acceptance trials. Acceptance trials are conducted by the government and determine a ship's suitability for delivery through a series of test events.

The program could avoid similar issues in stage 2 by ensuring all critical technologies are matured to a TRL 7 prior to its preliminary design review, since it did not do so by when it began detail design and construction.

Design Instability Led to Construction Rework and Contributed to Delays

The OPC program has not completed important elements of the stage 1 design despite having begun construction on all four ships. This design instability has led to construction rework and contributed to schedule delays of the delivery of OPC 1 by almost 2 years.

According to program officials, the OPC functional and transitional design is 98 percent complete as of January 2023. However, our review of design drawing documentation in March 2023 shows that about 91 percent of the functional design drawings were fully approved with no Coast Guard comments, meaning the drawings had no outstanding issues needing to be adjudicated. The remaining about 9 percent of the drawings have technical or administrative comments that ESG needs to resolve before the drawings will be final. Each of those drawings ranged from 50 to 90 percent complete as of March 2023. Coast Guard officials told us most of the incomplete functional design drawings are related to the distributive systems like heating, ventilation, and air conditioning (HVAC), where according to these same officials, design modifications have less effect on ship construction.[27] However, the Coast Guard ship design team—responsible for the technical design of shipbuilding programs service-wide—also stated that it is important to have key systems, including distributive systems, at a high level of design completeness ahead of construction start. Distributive systems typically affect multiple zones of the ship, meaning that any updates to the design resulting from resolving open comments on a distributive system drawing may have reverberating effects across the ship. The incomplete drawings also include other key systems, such as the davit. The program is experiencing rework due to these key systems' designs not being fully complete, which has in part, contributed to the almost 2-year delay of the lead ship delivery. For example:

- **HVAC.** Design drawings for the HVAC system diagrams and equipment list were 70 percent complete as of January 2023. The Coast Guard ship design team told us they approved production start on OPC 1 because they believed there was sufficient time for the shipbuilder to complete the HVAC design. However, ESG was unable

[27]HVAC is a distributive system that includes ducting and other systems that run throughout much of the ship spaces.

to execute this on schedule. ESG is in the process of fixing HVAC design issues that it found during installation. According to the program office, if the HVAC design details do not mature, then design changes will continue to occur in production that will create inefficient rework on installed systems, potentially delaying ship delivery.

- **Davit.** Davit design drawings were 70 percent complete as of January 2023. Design changes to the davit have thus far led to a complete overhaul of the electrical cabinet configuration, as previously discussed. However, since the davit has yet to mature or undergo integrated system-level testing, the risk remains high that additional changes to the design will be required, so this 70 percent completion status is likely optimistic. Continued design changes during the construction phase is inefficient, and can lead to delays and cost growth.

Concurrency between technology development, design, and construction in the OPC stage 1 program occurred at a time when the Coast Guard lacked a policy that established design and technology maturity parameters that programs should follow by certain phases of the acquisition cycle. In an effort to prevent future programs from following a similar high-risk approach, we recommended in October 2020 that the Coast Guard revise its acquisition policy to include criteria and a methodology for demonstrating design maturity in its shipbuilding programs that are aligned with shipbuilding leading practices and to minimize design and construction concurrency. In August 2022, the Coast Guard's Assistant Program Executive Officer, Surface, issued a standard operating procedure (SOP) that established design maturity parameters its shipbuilding programs should achieve before moving into production. Subsequent to sending this report out to comment, in May 2023, the Coast Guard updated the SOP to require critical technologies be matured to a TRL 7 prior to production readiness review.

While this SOP is an improvement, we found that it does not fully meet leading practices for shipbuilding, which requires maturing critical technologies to a TRL 7 by the time of contract award for detail design and construction, and the completion of basic and functional designs prior to the start construction.[28]

[28]GAO-09-322. Our leading practices for evaluating technology readiness also recommend that critical technologies reach TRL 7 at the decision point to start system development. See GAO-20-48G.

For example, the Coast Guard's SOP does not require programs to mature critical technologies to a TRL 7 by the time of contract award for detail design and construction, but rather not until much later when the program is about to proceed with production. Further, the SOP also does not meet the leading practice for functional design completion, since the minimum design maturity levels it states are for completion of 95 percent of functional design and 70 percent of transitional design before construction begins.[29] The leading practice calls for completion of functional design before start of construction. The difference between 95 and 100 percent is significant because the content of the remaining 5 percent of functional design work may be critical to ensuring design maturity. For example, if distributive systems that run through multiple compartments and decks of the ship are part of the 5 percent that is not complete, as demonstrated with OPC 1, starting construction would bring risk of delays and cost growth.

In our prior work on Navy shipbuilding programs, we found that the Navy attained varying levels of design completion prior to starting ship construction. This was contrary to commercial shipbuilding programs that are characterized by high levels of knowledge at key junctions throughout the acquisition process. In May 2009, we recommended, and DOD concurred, that a shipbuilding acquisition approach should include design being stabilized by the start of construction for a new ship.[30] Related to this recommendation, the National Defense Authorization Act for Fiscal Year 2022 established a requirement that the Secretary of the Navy certify to the congressional defense committees that a ship's basic and functional design are 100 percent complete before approving the start of a lead ship's construction.[31] The statute also defines basic and functional design to include the routing of major portions of all distributive systems of the vessel, including electricity, water, and other utilities.

[29]Coast Guard officials define functional design as including completing 2D design artifacts such as topside arrangement drawings, piping system calculations, and one-line diagrams. Coast Guard officials define transitional design as including completing a 3D model to capture the functional design and space arrangements populated with equipment, components, and systems, which is used to generate the production design. These definitions generally align with our definition of functional design as outlined in table 2.

[30]GAO-09-322.

[31]Pub. L. No. 117-81, § 1013 (2021) (codified at 10 U.S.C. § 8669c). This statute applies to Navy combatant ships and support vessels required for the Navy vessel force, and does not apply to Coast Guard cutters.

Although OPC stage 1 construction started in September 2018 and thus predated the Coast Guard's SOP, the program met the parameters outlined in the SOP by achieving—according to the program office—97 percent completion of functional design prior to lead ship construction. However, since that completion rate did not include key distributive systems such as HVAC, as discussed above, the shipbuilder encountered challenges and rework in the construction phase as the HVAC design changed. Completing functional design fully ahead of construction start may have reduced the need for additional rework.

Further, while the Coast Guard's SOP establishes minimum preproduction levels of design maturity, it states that a program's inability to meet those levels at the production readiness review will require Program Executive Officer review and concurrence to begin production. Coast Guard officials told us that this aspect of the SOP affords shipbuilding programs the flexibility to find the right balance between sufficiently maturing design to minimize risk and beginning production to meet shipyard and fleet needs. Furthermore, Coast Guard officials indicated that risks of moving forward into construction need to consider complexity of the vessel, stating that less complex vessels have lower risk of moving forward into construction with partially approved designs. While we understand that the Coast Guard faces time pressures to authorize shipyards to begin production and deliver assets to the fleet, our work on shipbuilding leading practices reflects the necessity of completing 100 percent of basic and functional design of a ship—regardless of complexity—before construction begins to minimize the risks of cost increases and schedule delays. Ultimately, by doing so, it ensures the fleet receives assets that meet the intended operational needs.

Because the Coast Guard did not reflect design maturity and technology maturity parameters that align with shipbuilding leading practices in its SOP or other acquisition policy and guidance, our recommendation from October 2020 remains open. By not revising its policy to reflect shipbuilding leading practices, the Coast Guard is increasing the risk that its future shipbuilding programs will experience design changes and the subsequent costly and out-of-sequence work these changes can cause. Given that there are other Coast Guard ship acquisition programs early in development, including not only OPC stage 2 but also the Polar Security Cutter, the Coast Guard could benefit from assuring that these programs attain design and technology maturity ahead of the milestones specified in shipbuilding leading practices. It could also benefit from updating and implementing its policy prior to the award of any future contracts for new ship construction. Further, without ensuring that its policy stipulate that all

distributive systems transiting multiple zones of the ship are fully designed before starting construction, nascent and future Coast Guard shipbuilding programs risk similar challenges and rework as experienced in OPC stage 1 construction.

Program Incurred Growth in Cost Estimate and Delays in Schedule, and Faces Further Risk Due to Construction and Performance Challenges

Since the OPC acquisition's inception in 2012, the program has incurred cost growth of over 40 percent and schedule delays of almost 1.5 years for delivery of the first four cutters. The program attributes its cost increase to several factors, including the damage caused by Hurricane Michael, additional costs incurred by the decision to award stage 2 to a new shipbuilder, and increased infrastructure costs. In addition, the program incurred schedule delays due to Hurricane Michael and a decision to change the installation sequencing of Navy-provided combat system equipment. However, we found indicators that other problems also pose additional risk to OPC cost and schedule, such as delays stemming from issues with propulsion shafting segments not conforming to specifications, and the shipbuilder's quantity of complex work remaining.

OPC's Acquisition Cost Estimate Has Increased

The OPC's total acquisition cost estimate, which includes program funded and non-program funded costs, increased by 41 percent between 2012 and 2022.[32] The increase in the acquisition cost estimate is in part attributed to increases in design and construction costs funded by the program. However, other factors also account for this increase, including an increase in other estimated costs that are not funded by the program, such as facilities acquisition, government-furnished equipment, and some outfitting and post-delivery work. Table 4 outlines the changes to the OPC acquisition cost estimates since the 2012 program life-cycle cost estimate.

[32]The OPC's total acquisition cost estimate, as laid out in its life-cycle cost estimate, includes program funded and non-program funded costs. The OPC's acquisition program baseline excludes non-program funded costs, meaning that the program's breachable costs only include those funded by the program. When we refer to costs that are "program funded" or "non-program funded," we are using Coast Guard characterizations of dollar amounts contained in OPC life-cycle cost estimate documentation.

Table 4: Estimated Acquisition Costs for Offshore Patrol Cutter (OPC) Program in 2012, 2018, 2020, and 2022 (in then-year billions of dollars)

	2012 cost estimate	2018 cost estimate	2020 cost estimate	2022 cost estimate	Percent change from 2012 to 2022
OPC costs funded by the program	$10.5	$10.3	$12.7	$12.5	19%
OPC costs not funded by the program	$2.0	$3.9	$4.3	$5.2	160%
OPC total acquisition costs	$12.5	$14.2	$17.0	$17.6	41%

Source: GAO analysis of OPC program life-cycle cost estimates. | GAO-23-105805

Of the OPC costs funded by the program, Hurricane Michael extraordinary contractual relief and the Stage 2 contract award have resulted in the highest increases:

Hurricane Michael extraordinary contractual relief. The program experienced an increase in its cost estimate between its 2018 and 2020 estimates due to damage caused by Hurricane Michael. In October 2018, Hurricane Michael—a category 5 storm—made landfall in the Panama City, Florida area causing widespread damage to the shipbuilder's facilities, significant disruption to its workforce, and depletion of its financial working capital. ESG determined that it could no longer perform to the terms of the contract, and as a result, requested schedule relief in March 2019 and cost relief of $740.3 million for OPCs 1 through 9 in June 2019. In October 2019, the Acting Secretary of Homeland Security determined that ESG's continued performance of the contract was essential to the national defense and used DHS's extraordinary contractual authority to grant up to $659 million in relief to ESG for continued performance, but directed that the contract be reduced to just the first four OPCs.

Stage 2 contract award. In addition to granting extraordinary contractual relief to ESG, the Acting Secretary of Homeland Security further directed the program to recompete the contract in support of a 25-ship OPC fleet. After a competition, the Coast Guard awarded the stage 2 contract, under which 11 OPCs can be constructed, to Austal in June 2022. In the program's 2020 cost estimate, the Coast Guard estimated $1.7 billion in additional acquisition costs compared to the 2018 life-cycle cost estimate. The $1.7 billion included $107 million for detail design and $1.6 billion for construction, and is attributed to assuming a new shipbuilder for stage 2, which includes OPCs 5 through 15. In the program's 2022 cost estimate, the detail design for the stage 2 award is estimated to cost $176 million, which is $69 million higher than originally estimated in 2020. Coast Guard officials also stated that the COVID-19 pandemic and inflation related to

the schedule delay all attributed to increases in these detail design and construction costs.

In addition, the total estimated cost of construction for the stage 2 ships has increased by $1.3 billion since 2018, before the Coast Guard recompeted the requirement for 11 of the remaining 21 cutters. The Coast Guard attributed the increase to Austal working through the challenges associated with designing and constructing a lead ship, such as identifying materials—design information, logistics, technical manuals, training manuals, shipping, storage, etc.—from suppliers. We also found that the cost of long lead time materials per ship nearly doubled in the stage 2 contract from when the Coast Guard exercised the option for long lead materials for the first OPC in 2017.[33] The Coast Guard attributes this increase to the cost of parts and equipment having increased. The Coast Guard also notes that the stage 2 shipbuilder elected to include some material buys in the phase typically used for long lead time orders rather than waiting until the construction phase to place orders early and mitigate supply chain delays being experienced. The increase aligns with what representatives from ESG told us based on their experience in ordering long lead time material for OPCs 3 and 4 due to supply chain issues stemming from the COVID-19 pandemic and global economic disruption.

The Coast Guard plans to award a contract for OPCs 16 through 25 at a later date, which would result in additional costs for another detail design effort should the Coast Guard award to a different shipbuilder. Further, based on our prior acquisition work, having two or more variants of the OPC could introduce new cost risk for the program since it will require at least two logistical supply chains, two separate operations and support processes, and potentially some additional crew training to account for differences in these systems.[34] Coast Guard officials said that the program is mitigating some of this risk by requiring standardization of the hull form and some specified major equipment from stage 1 to stage 2.

[33]Long lead time materials are components of a system or piece of equipment for which the times to design and fabricate are the longest, and therefore, to which an early commitment of funds may be desirable to complete the system by the earliest possible date.

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

Of the OPC costs not funded by the program, facilities acquisition, government-furnished equipment, and outfitting and post-delivery work have faced the most significant increases:

Facilities acquisition. OPC's facilities acquisition cost estimate—including homeports and shore facilities—increased from $431 million to $1.4 billion from 2012 to 2022.[35] Program officials said that the 2012 estimate assumed that the Coast Guard could use existing MEC homeports and Navy bases. However, based on homeport feasibility studies from 2018 and 2020, the Coast Guard attributed the cost estimate increase to:

- The Coast Guard's inability to leverage lower-cost Navy homeport options, as was originally assumed early in the OPC homeport planning effort. Officials said that the Coast Guard homeport requests at Naval Stations could not be supported due to pier space limitations and personnel increases that would exceed Navy support capacity;
- The high cost of waterfront real estate acquisition needed to accommodate OPC homeporting and docking, which was not originally accounted for in the 2012 cost estimate; and
- The high cost of infrastructure upgrades needed at Coast Guard homeports for environmental remediation, fixing the deteriorated condition of existing infrastructure, and the scale and complexity of waterfront, utilities, and shore-side infrastructure necessary to support OPCs.

As of February 2023, the Coast Guard has chosen three homeports and assigned the first four OPCs to two of them. The Coast Guard will continue to identify homeports for the remaining 21 OPCs. Table 5 captures these three homeport locations, along with the estimated cost and description of the planned work at each.

[35]Facilities acquisition costs are funded by the Coast Guard's Major Acquisition Systems Infrastructure Program and the Office of Civil Engineering.

Table 5: Current Homeport Projects in Support of the Offshore Patrol Cutter (OPC), as of March 2023

Location	Location Type	Estimated cost	Description
San Pedro, California	Coast Guard Base	$30 million	Project will extend the pier, upgrade shore ties, and construct an addition to the maintenance building to support OPCs 1 and 2.
Kodiak, Alaska	Coast Guard Base	$202 million	Project will upgrade waterfront facilities and construct a new maintenance building to support OPCs 3 and 4.
Newport, Rhode Island	Naval Station	$100 million	Project will rebuild piers and construct a maintenance support building for future OPCs. A 2020 homeport feasibility study analyzed options to accommodate two to four OPCs, but according to officials, no final determination has been made.

Source: GAO presentation based on U.S. Coast Guard information. | GAO-23-105805

Note: The homeports included are not an exhaustive list of planned OPC homeports; rather, they are a list of the homeports that have been approved and funded by the Coast Guard as of February 2023.

Other infrastructure costs include upgrades to facilities that house equipment such as the OPC's main diesel engines, generators, and operations center to support training on the basic operation and maintenance of the OPC equipment. Table 6 captures examples of facilities that will be upgraded for the OPC.

Table 6: Examples of Facility Upgrades in Support of the Offshore Patrol Cutter (OPC), as of March 2023

Facility	Location	Estimated cost	Description
OPC Dry Dock Lift at Coast Guard Yard	Baltimore, Maryland	$124 million	Project will construct a new floating dry-dock lift at Coast Guard Yard. While the Coast Guard included this requirement in the OPC's 2010 operational requirements document, it was not included in the program's initial 2012 cost estimate.
OPC Engine Training Facility	Yorktown, Virginia	$15 million	Project will construct an addition and renovate the existing engine training facility to add OPC training spaces.
OPC Mooring Upgrades at Coast Guard Yard	Baltimore, Maryland	$7 million	Project will install fenders and shore ties at the shoreline for OPC dockside maintenance activities at the Coast Guard Yard.
OPC Command, Control, Communication, Computer, Cyber, Intelligence, Surveillance, and Reconnaissance (C5ISR) Training Facility	Petaluma, California	$25 million	Project will construct an addition and renovate an existing C5ISR training facility to add OPC training spaces.

Source: GAO presentation based on U.S. Coast Guard information. | GAO-23-105805

Note: The projects included are examples of facility upgrades and are not an exhaustive list of planned facility upgrades in support of the OPC.

Government-furnished equipment. Government-furnished equipment that is not funded by the program—including the program's NTNO combat system equipment and Coast Guard small boats—increased from an estimated $1.2 billion to an estimated $2.1 billion from 2012 to 2022. Most of the increase occurred with the 2018 estimate after the program settled on the combat systems that would go on the OPC. For example, the program accounted for additional NTNO equipment, such as a radar system that the program estimated to cost $420 million for all OPCs. According to the program's 2022 cost estimate, the Coast Guard estimates the average cost of government-furnished equipment not funded by the program at about $85 million per cutter. The combat and navigation systems are Navy-owned systems, and, therefore, will be funded by the Navy. Other equipment, such as the small boats, are funded by other Coast Guard organizations.

Outfitting and post-delivery. Outfitting and post-delivery work includes work performed in the time period following delivery until the ship leaves the shipyard. The non-program funded outfitting and post-delivery cost estimate includes the Combat System Equipment Guide, technical manuals, and the sensitive compartmented information facility (SCIF) on the cutter.[36] The cost estimate increased from $0 to almost $1 billion from 2012 to 2022. Most of the increase occurred with the 2018 estimate, as the program did not initially account for any of the outfitting and post-delivery work not funded by the program in its original 2012 cost estimate. The Coast Guard used outfitting and post-delivery elements from its National Security Cutter program cost estimate to help identify the post-delivery work needed. The SCIF accounts for 98 percent of the cost estimate for the non-program funded outfitting and post-delivery work. The SCIF equipment for OPC stage 1 will be Navy-Type Coast Guard-Owned, which means the initial purchase and installation will be funded by the OPC program, with life-cycle support costs funded by the Navy. Coast Guard officials said they are working with the Navy to have SCIF equipment for OPC stage 2 designated and funded as NTNO.

Delivery of OPCs Delayed Due in Part to Issue with Propulsion System

The OPC program schedule incurred delays to stage 1 cutter delivery dates because of Hurricane Michael and changes in its combat system scope and installation sequencing. The program now also faces further delays to delivery of OPCs 1 through 4 due to an emerging manufacturing

[36]A SCIF is a specially outfitted space accredited for use with especially sensitive information. The program also funds other outfitting and post-delivery work that includes follow-up operational test and evaluation, air services during testing, and combat system ship qualification trials, among other things.

issue with propeller shafting segments, the part of the propulsion system that transmits power from the engine to the propellers to generate thrust.

The contractual delivery dates of the first four OPCs are currently at least 17 months later than the dates contemplated in 2017. This delay includes the extraordinary contractual relief granted to the shipbuilder following Hurricane Michael that resulted in schedule relief to the deliveries of OPCs 1 through 4, ranging from 10 to 12 months. It also includes delays to OPC 1 and 2 stemming from the program's decision to install NTNO equipment—including weapon and radar systems—during OPC stage 1 production instead of in the post-delivery period, as originally planned. The program's 2022 delivery schedule—which includes these revised OPC 1 and 2 delivery dates—ultimately reflects delays in estimated delivery dates for all stage 1 ships by between 6 and 10 months from the program's 2020 delivery schedule. In April 2022, the program began working alongside ESG to resolve a shafting manufacturing issue identified during shaft installation that will prevent ESG from meeting the contractual delivery date for OPC 1, and according to Coast Guard Officials, will also affect the schedules and delivery dates for OPCs 2, 3, and 4.

During installation of the shafts on OPC 1 in December 2021, ESG identified an alignment issue with the propeller shafting provided by its subcontractor, in which the port shaft segment was physically unable to fit to its corresponding coupling. After removal and remeasurement of OPC 1 and 2 shafting and final inspection of OPC 3 shafting at the manufacturer's facility in summer 2022, all segments were identified as having various nonconformities. The cause was determined to be a manufacturing defect issue in the shafting provided by the forging subcontractor, including lack of concentricity and out-of-tolerance shaft thickness.

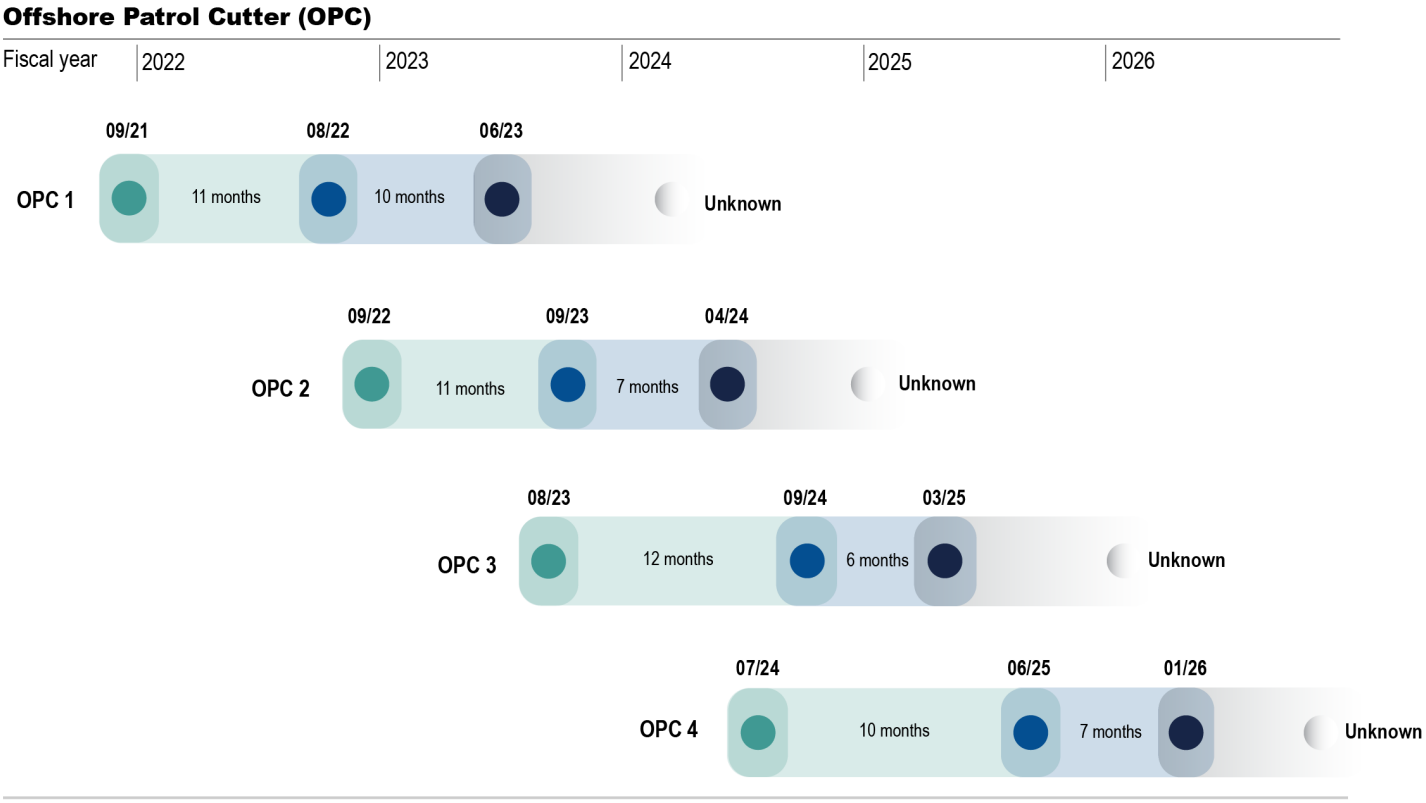
To address the schedule risk posed by the noncompliant shafting, ESG and Coast Guard officials are pursuing a parallel path strategy that includes both accelerating manufacturing of the new OPC 3 shafting from the subcontractor and repairing the least out-of-tolerance shafting segments from OPC 1 and 2 to use on OPC 1. As part of this strategy, Coast Guard officials told us they would initially accept shafting that does not meet the contract specifications, which will necessitate that ESG submit a request for variance, and at a later date provide compliant

shafting segments that would be later retrofitted onto delivered cutters.[37] Coast Guard officials stated that they would not accept any requests for variance that affected ship performance, such as speed and maneuverability. But, they also stated that they are willing to accept nonconformities that prevent initial shafting uniformity among the remaining OPC fleet, with the understanding that the affected shafting would be replaced at a later date with segments that do fully meet the requirements. Coast Guard officials told us that a prerequisite for moving ahead with the request for variance is that ESG guarantees that vendors for the equipment that interfaces with the shafting segments will operate normally and maintain their warranty despite this temporary variance.

Coast Guard officials told us they had a meeting with ESG in January 2023, during which the shipbuilder confirmed that all planned repair work for the temporary solution had been completed at the offsite repair facilities. The schedule proposed at this meeting had all shafting segments due to arrive at the shipyard no later than the end of March 2023, assuming the request for variance would be signed in early February. However, as of early March 2023, Coast Guard officials told us that they have yet to receive an acceptable request for variance from ESG. Given these time frames, Coast Guard officials told us that the OPC 1 contractual delivery date of June 2023 is no longer realistic, and that ESG now plans to deliver the lead ship at least 6 months later. They also told us that the new conforming shafting for OPCs 2, 3, and 4 will be available 9 months later than planned for each ship, which will impact their respective delivery dates. Figure 7 outlines the delivery schedules for OPCs 1 through 4 since 2017.

[37]For the purposes of this report, request for variance describes a contractor's proposed departure from (i.e., a nonconformance with) the contract specifications for a specific component or unit for a specified period of time.

Figure 7: Delivery Schedules for the Coast Guard's OPC 1 through 4 since 2017



Source: GAO analysis of U.S. Coast Guard documentation. | GAO-23-105805

[a]According to Coast Guard officials, the decision to shift Navy-type Navy-owned equipment installation ahead of delivery did not affect the delivery dates for OPCs 3 and 4. They attributed the change to the OPC 3 delivery date to supply chain issues that delayed construction start.

[b]The exact effect of the shafting issue on OPC delivery dates is currently unknown, but Eastern Shipbuilding Group's schedule as of March 2023 indicates that OPC 1 delivery is planned for February 2024, OPC 2 for January 2025, OPC 3 for March 2025, and OPC 4 for January 2026. However, Coast Guard officials said they anticipate 9-month delays to the shipyard's receipt of shafting for OPCs 2 through 4, which they said will impact delivery. They told us they are still performing analysis to determine projected delivery dates.

Complex Remaining Work and Inefficient Performance Suggest Future OPC Cost Growth and Schedule Delays Are Likely

Offshore Patrol Cutter (OPC) 1 Distributive Systems Not Completed

We observed the build strategy that sequenced distributive system work as following after completion of ship structure during a site visit to Eastern Shipbuilding Group's shipyard in April 2022. During our tour of the lead ship, we saw that units were erected into the structure of the ship, but the internal spaces were largely not yet outfitted with electrical cabling, ventilation, or other distributive equipment, resulting in many spaces that were largely empty. See for example, OPC 1's Combat Information Center as of June 2022:

Source: © 2022 Eastern Shipbuilding Group, Panama City, Florida. | GAO-23-105805

Ongoing and potential future challenges during the construction phase—like the complexity of remaining work on OPC 1 and a track record of contractor performance inefficiencies—increase the risk that stage 1 cutters will be behind schedule and over cost. Based on our analysis of shipyard data on construction progress, we found that there is a considerable amount of complex work that needs to be completed, which will likely also compound these delays and risk future effects on stage 1 delivery dates. Coast Guard officials told us that the build strategy for OPC 1 was to focus on completion of general hull structure first, and then go back in and complete distributive system work, such as ventilation, piping, and electrical cabling. This strategy is reflected in the data we analyzed on remaining work for OPC 1. For instance, although OPC 1 construction was about 82 percent complete as of October 2022, 47 percent of ESG's estimated labor hours remaining were related to completing the distributive systems for the ship. As shown in table 7, among the top 10 work categories with the highest estimated remaining number of labor hours to OPC 1 completion as of October 2022, four—including the highest—were related to distributive systems (indicated in gray highlights).

Table 7: Top Eastern Shipbuilding Group (ESG) Work Categories to OPC 1 Completion, by Estimated Remaining Labor Hours as of October 2022

Work breakdown structure[a]		Estimated labor hours	
Program element	Work category	Number remaining	Percent of total remaining
300: ELECTRICAL PLANT, GENERAL	ELECTRIC CABLES	113,869	19.7%
000: GENERAL ADMINISTRATION	TEST REQUIREMENTS	69,332	12.0%
400: GENERAL REQUIREMENTS FOR ELECTRONICS SYSTEMS	INSTALLATION OF ELECTRONIC SYSTEMS	42,868	7.4%
100: HULL STRUCTURE , GENERAL	AUXILLARY SYSTEM FOUNDATIONS	39,672	6.9%
500: AUXILIARY SYSTEMS, GENERAL	DESALINATION PLANTS, FRESH AND POTABLE WATER SYSTEMS	25,584	4.4%
800: INTEGRATION/ENGINEERING	DESIGN SUPPORT	22,554	3.9%
000: GENERAL ADMINISTRATION	HUMAN SYSTEMS INTEGRATION	20,146	3.5%
500: AUXILIARY SYSTEMS, GENERAL	PLUMBING, PLUMBING VENTS AND SPACE WEATHER DECK DRAINS	18,033	3.1%
100: HULL STRUCTURE , GENERAL	FOUNDATIONS - DETAIL	17,391	3.0%
500: AUXILIARY SYSTEMS, GENERAL	ENVIRONMENTAL POLLUTION CONTROL SYSTEMS	14,983	2.6%

Source: GAO analysis of Eastern Shipbuilding Group's earned value management data. | GAO-23-105805

Notes: Gray highlights indicate program elements 300 and 500, which ESG identified as among those comprising distributive system work. However, other work categories, such as "Installation of Electronic Systems," may also require complex work across multiple zones of the ship. The estimated labor hours remaining include ESG's estimated labor hours, and not subcontractor work, such as engineering drawings or dock and sea trials for subcontracted equipment.

[a]A work breakdown structure deconstructs a program's end product into smaller specific elements that are suitable for management control. The work breakdown structure is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives.

Our past work has demonstrated that this type of distributive system installation work can be complex, resource intensive, and high-risk.[38] As an example, Coast Guard officials told us that during installation of electrical cable on OPC 1, ESG realized that not all the cabling was fitting correctly and there were more efficient ways to run it through the ship. The design rework and rerouting of the cabling caused the overall construction completion rate for the ship to decrease slightly in September 2022 compared to the previous month, and also delayed system integration and testing. As previously shown in Table 7, electrical

[38]GAO-09-322; and *Ford-Class Aircraft Carrier: Congress Should Consider Revising Cost Cap Legislation to Include All Construction Costs*, GAO-15-22 (Washington, D.C.: Nov. 20, 2014).

cable installation leads all the other categories of estimated work needed for completion. Shipbuilding leading practices indicate that shipbuilders should complete as much design and installation of distributive systems as possible prior to unit erection and again before the ship being launched.[39] This is because it is generally less efficient to perform work on a ship after launch, and more expensive in later stages of construction.[40] Despite the remaining work required to complete distributive system installation, the shipbuilder still planned to move ahead with a launch date of August 2022 for OPC 1.[41]

Key Management Tool: Earned Value Management

Earned value management (EVM) is a project management tool that integrates the technical scope of work with schedule and cost elements, and compares the value of work accomplished in a given period with the value of the work expected in that period. When used properly, earned value management can provide objective assessments of project progress, produce early warning signs of impending schedule delays and cost overruns, and provide unbiased estimates of anticipated costs at completion.

Source: GAO, Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs, GAO-20-195G. | GAO-23-105805

Performance data tracked by ESG also indicate it may be difficult to meet the OPC schedule on time and on budget. In our analysis of ESG's earned value management (EVM) data from December 2021 through May 2022, the metrics measuring schedule and cost performance reflected generally poor performance across a majority of work categories for OPC 1 and 2. This indicated that certain work activities were behind schedule and over cost. For example, as of March 2022, the OPC 1 indicator measuring schedule performance was 0.74.[42] This means that for every dollar planned, the program was accomplishing 74 cents of work. Generally, a program is considered to be struggling if it does not achieve at least 90 cents of work for every dollar planned, according to leading practices for managing program costs.[43] In September 2022, as a result of the contract modification for the NTNO weapons system

[39]A launch is when the ship is conveyed from its building site into the water.

[40]For example, shipbuilders described a "1-3-8 rule," where work that takes 1 hour to complete in a workshop takes 3 hours to complete once the steel panels have been welded into blocks, and 8 hours to complete after a block has been erected or after the ship has been launched. See GAO-09-322. Moreover, our prior work has shown that the magnitude of cost growth occurs in later phases of construction—after ships are 60 percent or more complete. See GAO, *Defense Acquisitions: Realistic Business Cases Needed to Execute Navy Shipbuilding Programs,* GAO-07-943T (Washington, D.C.: July 24, 2007).

[41]Coast Guard officials told us that after the extent of the shafting nonconformities became apparent, the program and shipbuilder agreed to delay the planned launch date. As of March 2023, Coast Guard officials told us that OPC 1 has yet to launch.

[42]This indicator is known as the schedule performance index (SPI), which measures the ratio of work performed (or earned value) compared to the initial planned schedule. An SPI less than 1 indicates that work is not being completed as planned and the program may be behind schedule if the incomplete work is on the critical path. An SPI greater than 1 means work has been completed ahead of the plan.

[43]GAO, *Cost Estimating and Assessment Guide: Best Practices for Developing and Managing Program Costs*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020).

installation change, Coast Guard and ESG conducted an integrated baseline review for OPC 1 that rebaselined the schedule for OPC 1. This update improved ESG's schedule performance in the EVM data, as the rebaseline incorporated schedule changes from the NTNO contract modification.

However, ESG continues to underperform according to other EVM indicators, which suggests the contractor would have to significantly increase its efficiency in terms of time and money spent to meet its estimated cost at completion.[44] For example, to meet its estimated cost for OPC 1 completion, ESG must produce $1.08 worth of work for every dollar spent. Given that ESG's actual past performance on this ship is 76 cents worth of work for every dollar spent, the shipbuilder's efficiency is unlikely to improve enough to meet its estimated labor hour or cost goals for OPC 1, meaning ESG is at risk to incur significant losses if they continue at this efficiency level.[45] For example, ESG estimates that as of October 2022, there were about 580,000 labor hours remaining to complete OPC 1, but based on EVM data on ESG's actual performance, our estimates for remaining labor hours required to complete construction are 1.5 to 2 times higher than the shipbuilder's estimate.[46]

As performance effects are realized and cost and schedule overruns occur, there are decreased opportunities for oversight in the near-term. The current acquisition program baseline has a 5-year gap between acquisition milestones—the last event occurring in 2020 and the next not planned until 2025—which limits opportunities for DHS and the Coast Guard to conduct performance assessments against the program's official baseline.[47] Moreover, the Coast Guard excluded key hull delivery dates in the acquisition program baseline, which allows delivery delays to occur

[44]Estimate at completion is an assessment of the cost to complete authorized work based on a contractor's historical EVM performance.

[45]The options for the construction of OPCs in ESG's contract were fixed-price incentive (firm-target) type. The fixed-price incentive contract type generally fixes the government's maximum obligation to pay at a ceiling price, which is negotiated at the outset of the contract. See FAR 16.403-1.

[46]Our estimates indicate the remaining labor hours remaining to complete OPC 1 for the subset of distributive system work is three to five times more labor hours than estimated by the shipbuilder for that effort.

[47]The most current program baseline from 2020 contains a 5-year gap between critical program milestones: Acquisition Decision Event 2C occurred in March 2020 and Initial Operational Test and Evaluation is currently scheduled to occur in 2025.

without significant consequences for the program. In October 2020, we recommended that the Coast Guard include these dates, and DHS concurred. However, the Coast Guard has not yet included these delivery dates in the baseline. Officials told us they intend to include lead and last ship delivery dates in the next update of the acquisition program baseline, which is planned for the second half of fiscal year 2023. In the meantime, given the 5-year time difference from one milestone to another, changes to delivery dates will not lead to official breaches to the schedule, or to the actions that are to follow a breach under DHS policy, such as establishment of a remediation plan.[48]

OPC Delays Will Exacerbate an Existing Operational Gap between MECs and OPCs

The Coast Guard faces an operational gap between the MECs and OPCs, and it is likely that the delays in OPC deliveries will exacerbate that gap. To address the potential operational capability gap resulting from the risk of the MECs failing before they are replaced by the OPCs, the Coast Guard started a more than $250 million acquisition program to extend the service life of six of the 270-foot MECs. Coast Guard officials said they built flexibility into the MEC SLEP contracts that could allow the inclusion of additional MECs, if necessary. The Coast Guard decided not to extend the service life of the 14 210-foot MECs, which are slated to be replaced first by the OPCs. Both classes of MECs continue to face maintenance challenges due to age and parts obsolescence.

SLEP Partially Addresses an Operational Gap between the MECs and OPCs

To address the risks of the aging MECs failing before they can be replaced by the OPCs, the Coast Guard initiated a MEC SLEP in 2018 that is intended to extend the service life of six of the 13 270-foot MECs. In July 2019, DHS approved ADE 2A/2B for this more than $250 million acquisition program, which allowed the program to enter the obtain phase of the DHS acquisition life-cycle framework. The SLEP is intended to add up to 10 years of service life for each of the six MECs undergoing service life extensions, which will help mitigate the gap before OPCs are delivered. All of the 270-foot MECs have exceeded their original 30-year service life, with the oldest 270-foot MEC commissioned in 1983.

[48]According to DHS acquisition policy, programs in schedule breach status—generally, when a program fails to achieve a milestone by the threshold date in the acquisition program baseline—are generally required to notify their acquisition decision authority and component acquisition executive and develop a remediation plan that should outline a time frame for the program to either return to baseline parameters, rebaseline, or be subject to a DHS-led program review.

The MEC SLEP includes: (1) the remanufacturing of the main diesel engines—which are at the end of their service life—to help ensure reliability; and (2) an upgrade of the electrical system, which includes replacing the ship-service and emergency generators, which both provide electrical power to the ship. The SLEP will also include other upgrades, such as a structural refurbishment to components related to the propeller system.[49] The service life extension for each cutter is planned to take over 1 year to complete, and the MECs undergoing SLEP work will be unavailable for missions during this time.[50] The Coast Guard plans to conduct the SLEP at the Coast Guard Yard in Baltimore, Maryland, and, according to Coast Guard officials, will rely primarily on the government workforce and leverage experience from previous SLEPs for other Coast Guard assets.

To address the uncertainty of the OPC delivery schedule, the Coast Guard built flexibility into the SLEP contracts to extend the service life for additional MECs, if necessary. According to Coast Guard officials, they will not need to make a decision to expand the MEC SLEP beyond six MECs until 2025, which would allow the program enough time to procure long-lead time materials.[51] According to the Coast Guard, each additional MEC added to the SLEP program would cost approximately $44 million per cutter.

However, even with the SLEP, the Coast Guard faces an operational gap as a result of delays in the OPC delivery schedule. In a fleet mix analysis, published in 2023, the Coast Guard proposed a fleet size of 24 to 33 OPCs needed to sufficiently conduct operations.[52] As stated above, the Coast Guard's current plan is to acquire a fleet of 25 OPCs. Coast Guard officials said their goal was to sequentially decommission legacy assets

[49]Hull material replacements costs totaled $3.8 million for 2,000 square feet across four ships in fiscal year 2021, and $5.8 million for 2,687 square feet across four ships in fiscal year 2022.

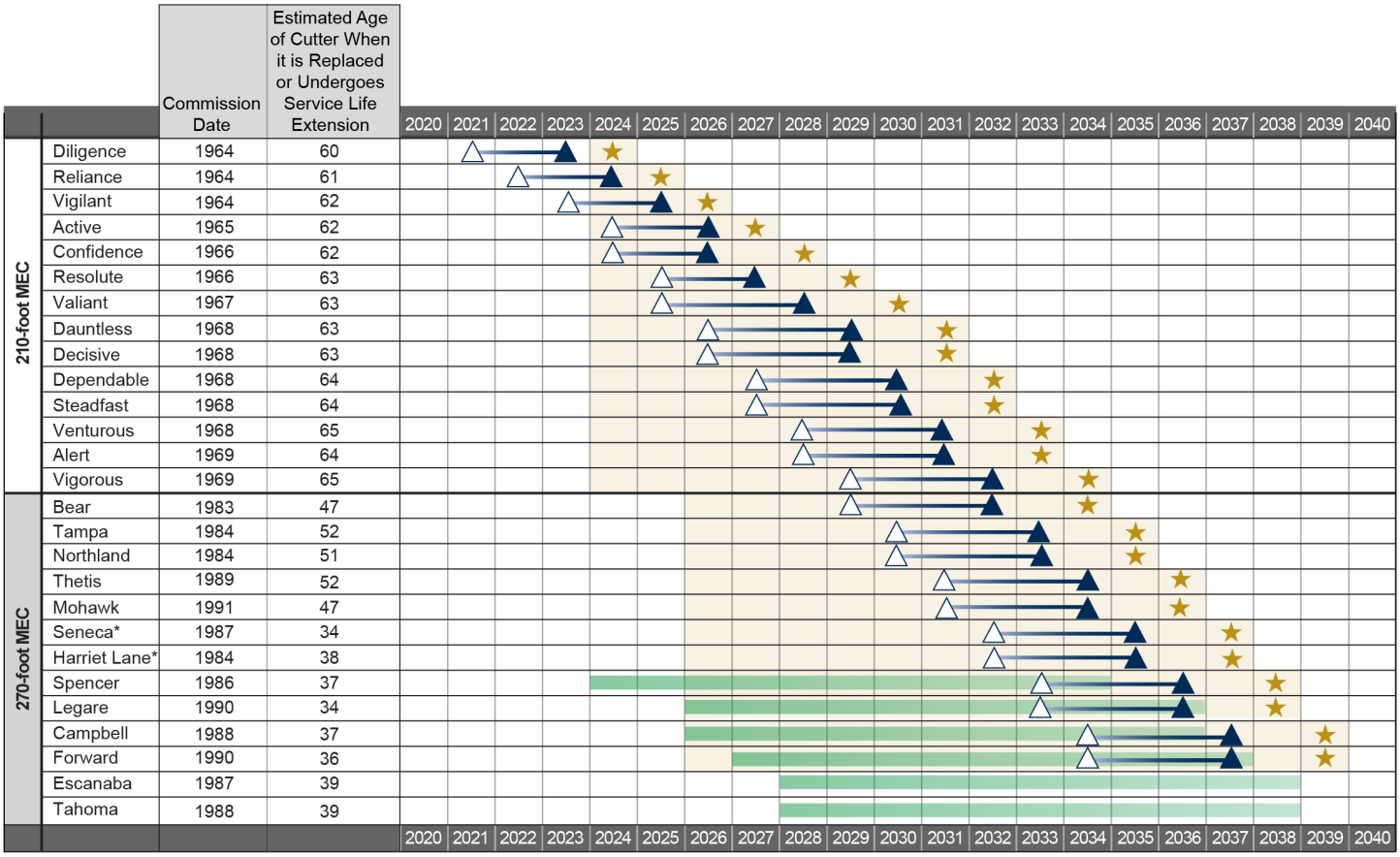
[50]Two of the MECs selected to undergo a service life extension will also be out of commission for approximately 8 months in order for the Coast Guard to integrate prototypes of the upgraded electrical system.

[51]The Coast Guard plans to decommission MECs based on assessments from the Office of Naval Engineering, as well as annual sustainability assessments. Coast Guard officials plan to be flexible in their decommissioning strategy, as factors such as maintenance needs, maintenance costs, and logistics all play a factor.

[52]The Coast Guard developed a fleet mix analysis that includes the proposed number of OPCs in response to language in the joint explanatory statements for the fiscal year 2023 and 2022 DHS Appropriations Acts. 168 Cong. Rec. S8553, S8564 (Dec. 20, 2022); 168 Cong. Rec. H1709, H2405 (Mar. 9, 2022).

as they are replaced by OPCs to maintain adequate major cutter force strength through the recapitalization period. Given the delays in the OPC program, the Coast Guard projects to have a reduction in asset availability—or a reduction in the number of cutters available for operations—starting in 2024 and through 2039, which is the current projected date for when OPC 25 will be ready for operations. See figure 8 for the Coast Guard's notional estimated decommissioning dates for the MECs based on commissioning date compared with the current OPC delivery schedule. While the MECs may not be decommissioned in the order depicted depending on the condition of each ship at the time, this figure helps depict the sequence of commissioning of the OPCs and decommissioning of the MECs.

Figure 8: U.S. Coast Guard's Estimated Medium Endurance Cutter (MEC) Service Life Dates Compared with Offshore Patrol Cutter (OPC) Delivery



Source: GAO analysis of U.S. Coast Guard documents. | GAO-23-105805

The reduction of asset availability in the transition plan could be further exacerbated by the design and manufacturing issues for OPC stage 1, as well as delays in the award of OPC stage 2 and the subsequent bid protest that were not accounted for in the Coast Guard's notional transition plan. For example, the OPC program is experiencing ongoing delays due to a propeller shafting manufacturing issue that needs

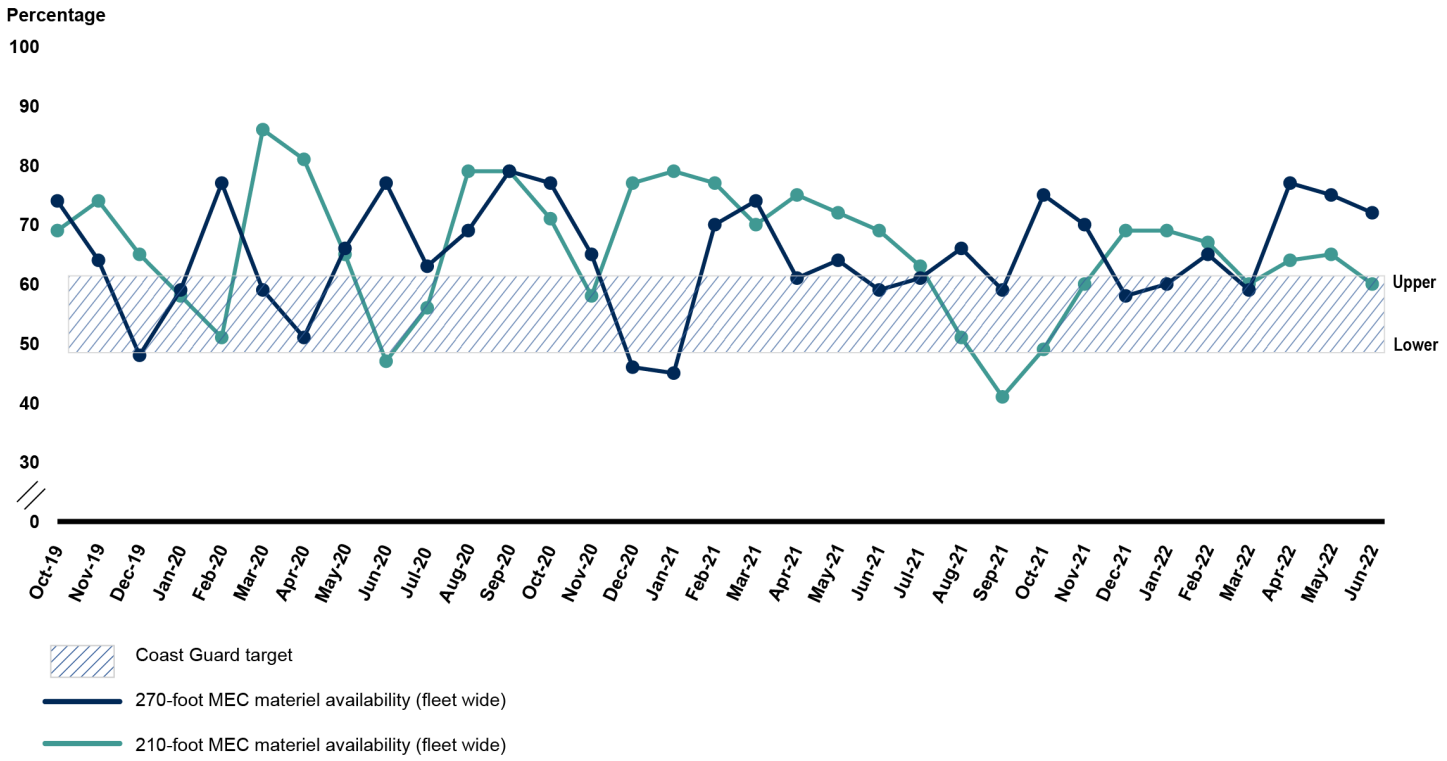
resolution. In addition, the program will delay delivery of OPC stage 2 ships by at least 6 months due to the delays of the contract award and subsequent bid protest. Austal also needs to complete a detail design for the stage 2 ship, and the Coast Guard needs to approve the design, before Austal can begin construction. These steps will likely lead to further delays for OPCs 5 through 15 at a minimum, requiring the Coast Guard to further maintain and keep the MECs in service longer or otherwise face a reduction of assets. Coast Guard officials told us that they do not anticipate the need to employ alternative options to meet mission requirements; however, officials stated that if the Coast Guard needs to decommission cutters earlier than planned, they could reallocate cutters to support emergent needs, employ other cutters to support missions previously handled by MECs, or extend the date for other planned decommissions to support continued operations.

MECs Risk Increased Maintenance and Operational Failures

Notwithstanding the age of the MECs, the Coast Guard generally maintained the MECs' materiel availability and operational availability metrics at or above target levels between October 2019 and June 2022. Materiel availability is the percentage of time that a cutter is available to fully or partially perform its mission, and includes the time it spends in depot maintenance. Operational availability is also the percentage of time that a cutter is available to perform its mission, but does not include the time it spends in depot maintenance. Officials from the Coast Guard's MEC Product Line, the office responsible for scheduling and coordinating fleet maintenance, tracks these two measures to monitor the health of the 210-foot and 270-foot MEC fleet.

Materiel availability. The 210-foot and 270-foot MECs had average materiel availability of 65 percent and 66 percent, respectively, from October 2019 through June 2022. The materiel availability generally remained within or above the Coast Guard's target threshold of 49 percent to 61 percent, as shown in figure 9. Coast Guard officials stated that the long lead times for parts, as well as part obsolescence, both pose a high risk to MEC materiel availability in coming years, as the MECs continue to age.

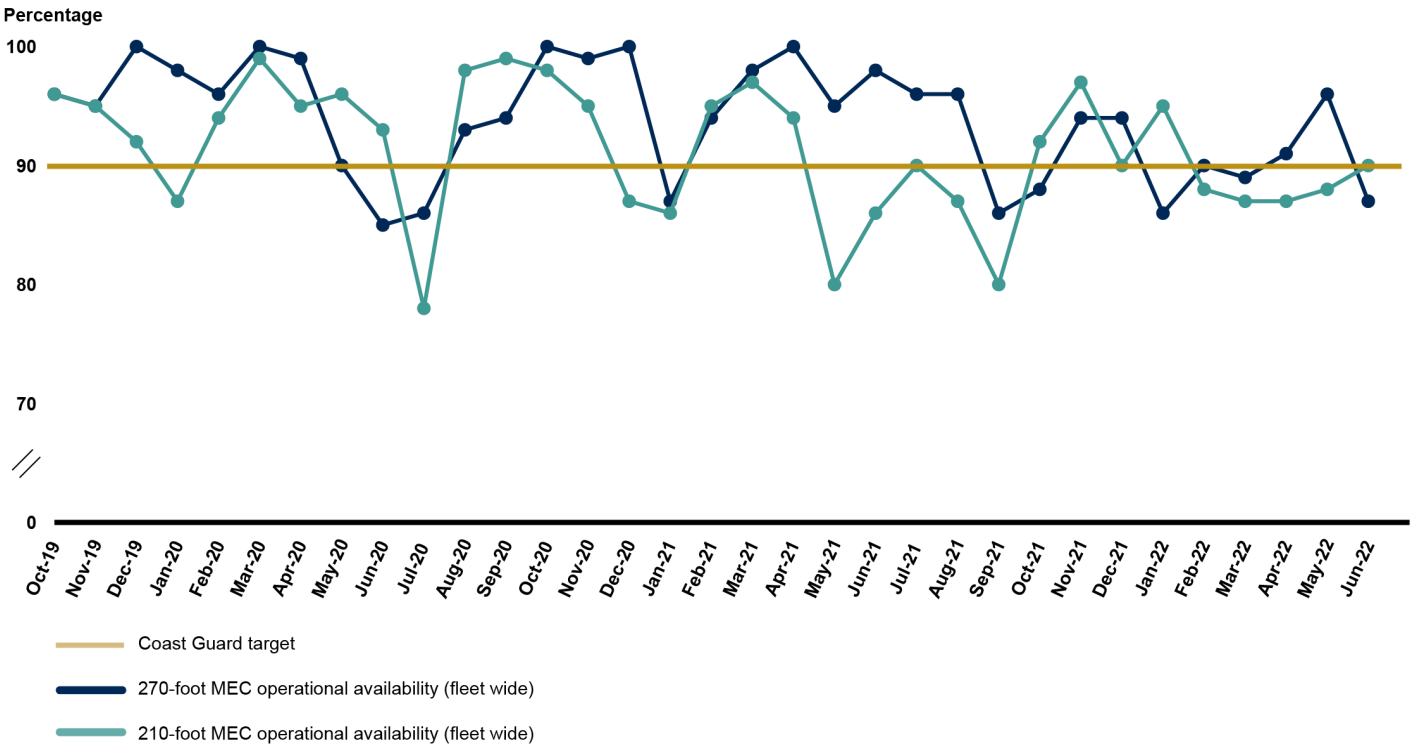
Figure 9: Materiel Availability for Medium Endurance Cutters (MEC) from October 2019 through June 2022



Source: GAO analysis of U.S. Coast Guard documentation. | GAO-23-105805

Operational availability. The 210-foot and 270-foot MECs averaged 91 percent and 94 percent, respectively, for operational availability from October 2019 through June 2022, as shown in figure 10. Coast Guard officials stated that they have no codified target range for operational availability at this time, though they stated their goal is to ensure MECs are operationally available at least 90 percent of the time. The percentage for operational availability is generally higher than materiel availability because materiel availability includes time that cutters spent in depot maintenance, while operational availability does not. This means that while planned dry dock cycles will negatively affect materiel availability, they will not affect operational availability. For example, if a MEC has planned dry dock maintenance in a given month, the materiel availability will be lower for that given month; the operational availability may not be lower unless there is another factor that would affect MEC operational availability.

Figure 10: Operational Availability for Medium Endurance Cutters (MEC) from October 2019 through June 2022



Source: GAO analysis of Coast Guard documentation. | GAO-23-105805

The Coast Guard attributes its success at maintaining its materiel availability and operational availability rates to various efforts underway to keep the MECs operational as long as possible, including implementing more specific maintenance plans based on the Coast Guard's extensive historical knowledge of the cutters and improving supply-chain logistics for replacement parts. Coast Guard officials said that, although future funding available for maintenance is uncertain, they have been able to target specific maintenance demands and defer other maintenance based on historical knowledge of the MECs' conditions and mission needs.

However, the Coast Guard acknowledged that the conditions of the MECs puts them at significant risk of decreased capability for meeting mission requirements. According to MEC sustainability assessments from 2021, the material condition—the operability, survivability, and sustainability of the ship—for five of the 13 270-foot MECs was considered poor with medium risk to mission capabilities. Similarly, three of the 14 210-foot

MECs were considered in poor condition with medium risk to mission capabilities.

In 2020, we reported that the Coast Guard noted in 2019 that the 210-foot MECs' obsolete propulsion systems present an increasing risk of operational failure.[53] Power for the propulsion system is supplied by the ship's main engine and main generator, and emergency generator should the latter fail. As failures of these systems increase in frequency, the MECs become increasingly unreliable. The Coast Guard refers to emergent operational failures of equipment as a casualty. In our assessment of MEC casualty reports from fiscal year 2021, crews on the 210-foot and 270-foot MECs experienced:

- 38 casualties with their propulsion systems. Three of those failures rendered the cutter disabled for 7 days on average.
- 95 casualties with their main diesel engines and generators, and 13 of these failures rendered the cutter disabled for about 6 days on average. The main diesel engines and generators are the second most frequent pieces of equipment to fail.
- 36 casualties to the emergency generators—which supply electric power to the engine in the event of the main power supply failure—during the same period, and seven of those casualties rendered the cutter disabled for about 16 days on average.

Crews on the 210-foot and 270-foot MECs also documented other casualties, including casualties with the hull and other habitability issues. For example:

- Crews on 270-foot and 210-foot MECs reported 148 casualties with the hull, and two of the casualties were disabling for about 12 days on average. The hull accounted for the highest number of casualties on the MECs, which includes issues with structural integrity, plating, and small boat engine coverings.
- Crews on 270-foot and 210-foot MECs reported 62 casualties with the HVAC systems. In cutter engineering reports, crews further explain that they experience problems maintaining HVAC systems and that HVAC inefficiencies have led to high levels of condensation and mold in crew living spaces, such as berthing areas, compromising crew comfort. Coast Guard crews told us they try to address these issues as they occur, but the number and frequency of maintenance issues

[53]GAO-21-9.

in addition to their regular mission duties make living in these conditions a fact of life. Figure 11 shows mold growing on pipes that are located directly above a bunk where the crew sleeps.

Figure 11: Mold in Berthing Area of a 210-foot Medium Endurance Cutter

Source: GAO photo taken on site visit. | GAO-23-105805

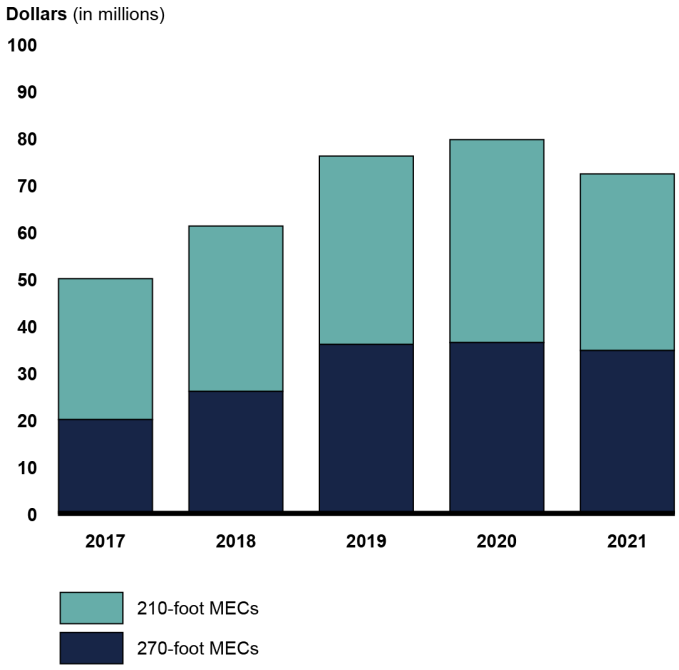
When discussing maintenance, MEC Product Line officials noted that they are identifying a growing number of repairs, both due to casualty

events and repairs identified during routine maintenance. Many of these issues will not be addressed in the SLEP, including HVAC; various maintenance issues with the embarked small boats; water tightness issues caused by rust and corrosion around some doors and hatch covers; weak internet connectivity; and maintenance issues with the boat davits.[54] According to Coast Guard officials, some of these issues are too expensive or complicated for the Coast Guard to fix. Appendix II details issues related to the hull, mechanical systems, electrical systems, habitability, and information technology that MEC crews identified in their engineering reports from 2019 through 2021.

In addition, organizational and depot maintenance costs are increasing. The cost of organizational maintenance—maintenance performed by crews that includes tasks like inspecting, servicing, and adjusting equipment, and other preventive and corrective maintenance, to support and maintain the ship's fully mission-capable status—increased from about $954,491 to $1.6 million for the 270-foot MECs, and from $722,340 to $913,297 for the 210-foot, from fiscal years 2017 to 2021. Similarly, annual cost of MEC depot maintenance—material maintenance or repair that requires overhauling, upgrading, or rebuilding of an asset or its components—for the 270-foot and 210-foot MECs increased from fiscal years 2017 to 2021. For example, depot maintenance costs for the 210-foot MECs increased from about $20 million to $35 million (see fig. 12). The increases in both organizational and maintenance costs indicate that crews and maintainers are either experiencing more frequent maintenance issues, or the maintenance has become more costly to address.

[54]Water tightness is tight construction or fit to make the ship impermeable to water.

Figure 12: Depot Maintenance Expenditures for Medium Endurance Cutters (MEC) from Fiscal Years 2017 through 2021



Source: GAO analysis of U.S. Coast Guard documentation. | GAO-23-105805

Costs for many key parts have increased significantly in recent years. For example, since 2019, the cost of a legacy davit has increased by about $60,000. A center section overhaul kit needed to repair a 270-foot MEC's main diesel engine has increased by $606,000, nearly doubling in price. These cost increases complicate the Coast Guard's efforts to keep these ships operational.

Officials from the MEC Product Line told us that they expect there to be increases in the cost of maintaining the MECs as they continue to age and move out of normal maintenance operations to keep the MECs operational until they can be decommissioned. We reported in October 2020 that the Coast Guard estimated that even after taking into account the MEC SLEP, annual maintenance costs for the 210-foot MECs could increase by approximately 80 percent from 2019 to 2035, while the annual cost for maintaining the 270-foot MECs could increase by

approximately 60 percent during the same period.[55] Additional delays to the OPC deliveries will also delay the decommissioning of the MECs and risk further increases in maintenance costs in order to maintain operational capability.

Conclusions

With planned spending of billions of dollars in the coming years, the Coast Guard plans to replace its fleet of MECs with OPCs. The OPC program continues to move forward with construction despite an unstable design, among other issues. Specifically, the Coast Guard began construction of the first four OPC ships without ensuring the shipbuilder sufficiently matured the OPC's critical technology—the davit—and stabilized its design. This has already resulted in rework during OPC construction, and the effect will likely compound as production progresses on all four ships. Absent developing a technology maturation plan and testing the integrated davit in a realistic environment prior to OPC 1 builder's trials, the Coast Guard will have little assurance that the shipbuilder will deliver a davit meeting the required capabilities, making it difficult to plan and budget accordingly. There is also an opportunity to reduce overlap of the technology development and design phases in OPC stage 2 by maturing any critical technology ahead of the next major design milestone of preliminary design review.

Further, the Coast Guard has an opportunity to reassess its strategies for the OPC program and correct mistakes made in stage 1 that resulted in construction start before completion of key system designs. Although the program is in early stages of OPC stage 2 design with Austal, the Coast Guard has yet to fully align its actions with shipbuilding leading practices. Specifically, the Coast Guard's policy and guidance do not require shipbuilding programs to (1) achieve a sufficiently stable design prior to the start of lead ship construction, and (2) successfully demonstrate all critical technologies identified by the program or shipbuilder in a realistic environment by contract award for lead ship design. Moreover, the guidance the Coast Guard issued in its SOP lacks explicit instruction to include routing of major portions of all distributive systems as part of functional design completion.

Given the uncertainty of OPC stage 1's ability to meet operational requirements, it is vital that the Coast Guard take a more proactive approach that prioritizes technology development and planning in stage 2 to prevent any further delays in an already existing operational gap. We

[55]GAO-21-9.

continue to believe that developing shipbuilding acquisition policy that fully aligns with leading practices for design maturity and technology development would better position the Coast Guard to avoid the risk that its future shipbuilding programs will face the same construction rework and resulting cost and schedule increases as the OPC program.

Matters for Congressional Consideration

We are making the following two matters for congressional consideration:

Congress should consider requiring the Coast Guard to update its acquisition policy to establish that all shipbuilding programs should mature critical technologies—including those that are developmental or that are novel in application or form, fit, and function—to a TRL 7 prior to a program's contract award for detail design and construction. This means that programs should successfully demonstrate the integrated prototypes of all critical technologies identified by the program or shipbuilder in a realistic environment.

Congress should consider requiring the Coast Guard to update its acquisition policy to establish that all shipbuilding programs should achieve 100 percent completion of basic and functional design prior to the start of lead ship construction. This should include completing the routing of all distributive systems that transit electricity, water, HVAC, and other utilities, as part of functional design prior to the start of lead ship construction.

Recommendations for Executive Action

We are making five recommendations to the Coast Guard:

The Commandant of the Coast Guard should ensure that OPC program officials develop a technology maturation plan for the davit prior to builder's trials. This plan should identify potential courses of action to address davit technical immaturity, including assessing technology alternatives should the current davit continue to face development challenges, and a date by which the Coast Guard will make a go/no-go decision to pursue such a technology alternative. (Recommendation 1)

The Commandant of the Coast Guard should ensure that OPC program officials test an integrated prototype of the davit in a realistic environment prior to stage 1 builder's trials. (Recommendation 2)

The Commandant of the Coast Guard should ensure that the OPC stage 2 program follows shipbuilding leading practices by successfully demonstrating integrated prototypes of all critical technologies identified

by the program or shipbuilder in a realistic environment no later than preliminary design review. (Recommendation 3)

The Commandant of the Coast Guard should ensure that the Coast Guard Component Acquisition Executive, prior to any contract awards for new shipbuilding programs, updates its acquisition policy to establish that all shipbuilding programs must complete the routing and design of major portions of all distributive systems that transit electricity, water, HVAC, and other utilities, as part of functional design prior to the start of lead ship construction. (Recommendation 4)

The Commandant of the Coast Guard should ensure that the OPC stage 2 program achieves a sufficiently stable design prior to the start of lead ship construction. In line with shipbuilding leading practices, sufficiently stable design includes 100 percent completion of basic and functional design, including routing of major distributive systems and transitive components that effect multiple zones of the ship. (Recommendation 5)

Agency Comments and Our Evaluation

We provided a draft of this report to DHS for review and comment. DHS provided written comments, which we reproduced in appendix III. DHS and the Coast Guard also provided technical comments, which we incorporated as appropriate. In its written comments, DHS concurred with three of our five recommendations (recommendations 1, 2, and 4) and identified actions they plan to take to address them. DHS did not concur with two recommendations (recommendations 3 and 5).

DHS concurred with our first recommendation to develop a technology maturation plan that assesses technology alternatives and a go/no-go date to pursue such a technology alternative. DHS concurred with our second recommendation to ensure OPC program officials test an integrated prototype of the davit in a realistic environment prior to stage 1 builder's trials. DHS also concurred with our fourth recommendation to ensure that the Coast Guard update its acquisition policy to establish that all shipbuilding programs must complete the routing and design of major portions of all distributive systems that transit electricity, water, HVAC, and other utilities, as part of functional design prior to the start of lead ship construction.

DHS did not concur with our third recommendation to ensure that the OPC stage 2 program follows shipbuilding leading practices by successfully demonstrating integrated prototypes of all critical technologies identified by the program or shipbuilder in a realistic environment no later than preliminary design review. In its comments,

DHS stated that the OPC stage 2 program has one critical technology—the davit. It said that the shipbuilder selected a davit with a demonstrated pedigree in operational environments and is working through preliminary design assessments. It said the program will follow an iterative approach to attain davit design maturity, including Coast Guard review and approval of contract requirements at the preliminary and critical design reviews. However, DHS also said that it will not demonstrate the integrated davit in a realistic environment until after the preliminary design review.

We stand by our recommendation. In October 2020, we recommended that the Coast Guard update its acquisition policy to align with our shipbuilding leading practices, which includes maturing critical technologies to a TRL 7. DHS concurred with that recommendation, and the Coast Guard has taken initial steps to address it. DHS not concurring with this report's recommendation for the OPC program does not align with the spirit its prior concurrence from our 2020 report. The Coast Guard already awarded the contract for stage 2 detail design—with options for construction—in June 2022, and did not mature the davit to a TRL 7 in accordance with our leading practice. Preliminary design review is the program's next milestone for stage 2, and it would be prudent to demonstrate the davit in a realistic environment by then to minimize risk. Further, we disagree with DHS that the selected davit has a demonstrated pedigree in operational environments, and we remain concerned that the Coast Guard's approach is out of step with our identified leading practices. Specifically, the Coast Guard told us that there is no davit on the market—including from the vendor selected for stage 2—that meets all the performance requirements for the OPC. Thus, the davit for OPC stage 2 will be new in form and function unless the Coast Guard changes its performance requirements. We are concerned that the Coast Guard is proceeding down the same risky path as OPC stage 1, which carried technical risk with a developmental davit and moved through program reviews and into construction without the vendor adequately demonstrating maturity. These decisions have contributed to delays that persist in that program, and no viable davit has been delivered yet.

DHS also did not concur with our fifth recommendation to ensure that the OPC stage 2 program achieves a sufficiently stable design prior to the start of lead ship construction, including routing of major distributive systems and transitive components that affect multiple zones of the ship. In its comments, DHS stated that the program does not agree that the definition of a sufficiently stable design includes completion of basic and function design, including routing of major distributive systems and

transitive components that affect multiple ship zones. Rather, the program defines a sufficiently stable design as achievement of high confidence in functional design, and enough production design to support construction. DHS also stated that the Coast Guard issued a standard operating procedure (SOP) in August 2022, and updated it in April 2023, to address our October 2020 recommendation that the Coast Guard update its acquisition policy to reflect shipbuilding leading practices for achieving design stability and maturing critical technologies. DHS said that it monitors progress of design maturity at preliminary design, critical design, and production readiness reviews.

We stand by our recommendation. We are aware of the Coast Guard SOP, which DHS said Coast Guard issued in response to our 2020 recommendation to ensure completion of functional design and technology maturity. However, as we discuss in the report, we remain concerned that these updates do not align with our leading practices. The SOP states that programs should complete minimum design maturity of 95 percent of functional design by production readiness review. However, as we indicate in our report, our leading practices call for 100 percent of functional design to be complete by the start of ship construction. In addition, the SOP does not mention the routing of distributive systems within that 95 percent. As we stated in the report, Coast Guard's ship design team told us that it is important that routing of distributive systems be completed prior to the start of construction.

Further, DHS concurred with our fourth recommendation related to ensuring that the Coast Guard updates its acquisition policy to establish that all shipbuilding programs complete the routing and design of major portions of all distributive systems as part of functional design prior to the start of lead ship construction. By concurring with our recommendations regarding completion of functional design and routing of major portions of distributive systems, DHS agrees that the Coast Guard needs to update its acquisition policy to reflect our leading practices. However, the department falls short by not requiring the OPC program to implement our leading practices.

In light of DHS's disagreement with two of our recommendations, we are elevating these issues to the attention of Congress. In the coming years, Coast Guard will ask Congress to appropriate funding for OPC's stage 2 ships, as well as other programs like the Polar Security Cutter. Without a policy in place that requires the Coast Guard to achieve design stability that follows shipbuilding leading practices, Congress will likely not have

assurance that the Coast Guard is minimizing risk and the department is making sound investments.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Homeland Security, the Commandant of the Coast Guard, the Secretary of Defense, and other interested parties. 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 about this report, please contact me at (202) 512-4841 or makm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to the report are listed in appendix IV.

Marie A. Mak
Director, Contracting and National Security Acquisitions

Appendix I: Objectives, Scope, and Methodology

This report examines the extent to which (1) the Offshore Patrol Cutter (OPC) program's design and construction practices are consistent with shipbuilding leading practices, (2) the OPC program is meeting its cost and schedule goals, and (3) a gap exists between the decommissioning of the Medium Endurance Cutter (MEC) fleet and the deployment of the OPCs.

To assess whether the OPC program's design and construction practices are consistent with shipbuilding leading practices, we interviewed officials and reviewed documentation from the Coast Guard's OPC program office, OPC on-site project resident office, and ship design team. We also interviewed officials from the Department of Defense's Defense Contract Management Agency and Program Executive Office for Integrated Warfare Systems, and representatives from the American Bureau of Shipping on the program's design and construction progress, critical technology maturity, cost risks, and schedule risks. We conducted a site visit to the Eastern Shipbuilding Group (ESG), the current OPC stage 1 shipbuilder, to meet with ESG representatives and tour the lead ship and shipyard.

We reviewed materials on design and construction progress and risks, such as design drawing completion and approval rates, the OPC risk register, Coast Guard engineering change notifications, proposals, and corrective action requests to ESG, and program briefing materials to DHS's Executive Steering Committee and Acquisition Review Board. We compared the program's progress with design and construction to leading practices that we identified for design and construction in shipbuilding.[1] We also reviewed Coast Guard documentation related to the OPC's sole critical technology—the small boat davit—including a 2020 technology readiness assessment, an October 2022 memo from the Ship Design Team on outstanding davit design concerns, and six contractual letters of concern sent to ESG regarding issues with davit contract deliverables. We compared the program's progress in maturing the davit to leading

[1]Specifically, the shipbuilding leading practices identified in GAO, *Best Practices: High Levels of Knowledge at Key Points Differentiate Commercial Shipbuilding from Navy Shipbuilding*, GAO-09-322 (Washington, D.C.: May 13, 2009); and *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP (Washington, D.C.: June 6, 2018).

practices for assessing technology readiness and maturing technologies, along with shipbuilding leading practices we previously identified.[2]

To assess the extent to which the OPC program is meeting cost and schedule goals, we identified and analyzed information related to both program costs and program schedule. To assess the cost performance of the OPC program, we analyzed acquisition cost estimates in the program's life-cycle cost estimates from fiscal years 2012 through 2022. We compared the 2022 cost estimate to other program documentation, including the acquisition program baseline and summary briefings from the program. We also interviewed OPC program officials on the main cost drivers and risks for the OPC program. We also discussed the program's rebaseline efforts, including updating its life-cycle cost estimate, in accordance with Department of Homeland Security (DHS) acquisition policy and guidance. For schedule, we reviewed OPC contract documents and key OPC program schedule information, including ship contract delivery dates, the shipbuilder's integrated master schedule, the program's integrated government schedule, and other schedule information presented at shipyard gate reviews between the shipyard and Coast Guard. We also reviewed the program's systems engineering life cycle to determine design reviews, acquisition phases, and test events for the program.

We assessed the shipbuilder's progress and performance on OPC stage 1 design and construction by analyzing earned value management (EVM) format 1 data for detail design and OPCs 1 through 3 from ESG's EVM system for the 6-month period of December 2021 through May 2022. After the OPC 1 integrated baseline review that adjusted the lead ship schedule, we analyzed EVM performance data for OPC 1 again in October 2022, including estimated cost and labor hours remaining to completion. In 2018, the Defense Contract Management Agency evaluated ESG's EVM system and identified significant deficiencies that were addressed in a corrective action request and plan. In October 2020, the agency determined that ESG's EVM system demonstrates the ability to produce data that can be relied upon to make informed decisions. The agency continues to monitor the system and perform regular surveillance of its compliance. After confirming the EVM system's certification and continued surveillance by the government, we performed various

[2]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); GAO-09-322; and GAO-18-238SP.

additional checks, such as verifying that the OPC program office reviews EVM data on a regular basis. We determined that these data were sufficiently reliable for our purposes of assessing relative performance and work remaining.

To determine the extent to which a gap exists between the decommissioning of the MEC fleet and the deployment of the OPCs, we reviewed MEC service life extension program (SLEP) acquisition documents, MEC engineering reports, and OPC acquisition and contract documents. We also analyzed the 210-foot and 270-foot MEC materiel availability and operational availability data from the Coast Guard's Electronic Asset Logbook database for October 2019 through June 2022 to determine how they compared with the Coast Guard's targets. We reviewed data standards and guidance for the Electronic Asset Logbook database and interviewed Coast Guard officials to determine that the data were sufficiently reliable for the purposes of reporting the operational availability and materiel availability. We also analyzed the Coast Guard's depot maintenance costs from fiscal year 2017 through 2021. We supplemented our analysis by conducting a site visit to tour operational 270-foot and 210-foot MECs—selected based on cutter availability in port and close proximity to the Coast Guard's maintenance yard—as well as a 270-foot MEC undergoing prototype SLEP work packages in that maintenance yard. On the 270-foot and 210-foot MECs, we interviewed ship leadership and crews involved in both operations and maintenance and asked them to show us key spaces onboard each ship. We also interviewed officials from the In-Service Vessel Sustainment office—the office responsible for the MEC SLEP—, the Coast Guard Office of Cutter Forces, and the MEC Product Line.

We conducted this performance audit from February 2022 to June 2023 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: Examples of Maintenance Concerns on 210-foot and 270-foot Medium Endurance Cutters

All cutters across the Coast Guard submit engineering reports annually that document maintenance concerns on the 210-foot and 270-foot Medium Endurance Cutters (MEC). Below are examples of maintenance concerns related to the hull, mechanical systems, electrical systems, and information technology, that 210-foot and 270-foot crews identified in their engineering reports from 2019 through 2021.

Corrosion. According to engineering reports, many interior and exterior doors on the 210-foot and 270-foot MECs have significant corrosion and need replacing. But the doors have a long lead time for replacement, and according to crews, are costly, and require significant time and resources to install since welding is required. This has an effect on both operational risk and crew safety, especially in situations such as flooding, firefighting, or chemical exposure scenarios where water tightness or a good seal are required for safety. Data on the Coast Guard's equipment casualty reports from fiscal year 2021 stated that issues with the hull are the most frequent casualties faced by MECs. Some corrosion also affects hull structural plating, which can be replaced but at high cost and time out of service.

While on a site visit to a 270-foot MEC, we observed that constant wetness in the galley—the area where crew prepares food—led to exterior hull corrosion, which is evidenced by the holes created during the paint removal process in dry dock (see fig. 13).

Figure 13: Corrosion through Exterior of 270-foot Medium Endurance Cutter

Constant wetness in the galley—area where crew prepares food—led to corrosion and holes through the frame of a 270-foot MEC, exposing the interior of the ship to the outside environment.

Source: GAO photo taken on site visit. | GAO-23-105805

While on a site visit to a 210-foot MEC, the crew pointed to areas where condensation from piping led to unsafe conditions. See figure 14 for an example where condensation from the piping leaked onto walkways, which the crew stated leads to corrosion and a slippery environment inside the ship where areas should be dry.

Figure 14: Condensation on Piping (left) and Corrosion on Slippery Surface (right) on 210-foot Medium Endurance Cutter (MEC)

Condensation from piping (left) leaks onto walkways (right) on a 210' MEC, leading to corrosion and a slippery environment.

Source: GAO photos taken on site visit. | GAO-23-105805

In addition, the crew on the 210-foot MEC identified areas where water tightness was a pervasive issue. See figure 15 for an example of where an exterior door that was exposed to the elements has led to rust accumulation on the door, risking the water tightness of the vessel.

Figure 15: Rust on Exterior Door on 210-foot Medium Endurance Cutter (MEC)

Rust on exterior door of a 210-foot MEC, which risks the water tightness of the vessel.

Source: GAO photo taken on site visit. | GAO-23-105805

Generators. The ship service diesel generators and emergency diesel generators on many 270-foot MECs have reached the end of their lives. According to engineering reports, spare parts for repairs are increasingly difficult to locate, and the quality of refurbished parts has been decreasing due to the number of times they have been refurbished. Both the ship service diesel generators and emergency diesel generators are obsolete equipment, and repair lead times are currently averaging 10 months. Based on the Coast Guard's equipment casualty reports in fiscal year 2021, the main diesel engine and generator were the second most frequent pieces of equipment to fail. The MECs also encountered a significant amount of failures with the emergency generators. Several of them were disabling, requiring the cutters to return to shore.

Davits. According to an engineering report, one 210-foot MEC's dual point davit malfunctioned during usage, losing power and stranding crew members 4 feet above the water. Another engineering report detailed that one 270-foot MEC's single point davit boom fills with water when not in use, corroding switches and sensors. Multiple other MEC engineering reports also noted that there is a lack of parts and resources to make davit repairs, and that repairs can be a time consuming and ineffective process. According to the Coast Guard, the legacy dual-point davit has a

19-month lead time for repairs, and a 15-month lead time to acquire a replacement. Unusable davits limit the cutters' capabilities to conduct their primary mission set.

Piping. According to engineering reports for the 210-foot and 270-foot MECs, piping systems and components, especially in sewage and auxiliary salt water systems, frequently fail, and require patching and cleanup often without warning, and requiring containment and cleanup. Crew members are trained to temporarily patch the systems, with more extensive repairs only able to be done in port.

Small boats. The small boats used by both the 210-foot and 270-foot MECs are aging and difficult to maintain, frequently suffering mechanical, electrical, and electronic casualties. One cutter reported spending an additional 100+ hours troubleshooting the boats to keep them operational, in addition to their regular shipboard maintenance schedule. Small boat electronics also frequently experience casualties due to corrosion from water intrusion, requiring the crew to spend significant effort repairing them. To ensure maintenance is kept up on small boats, Commanding Officers requested in their engineering reports that the support model be moved from the ship to shore support teams and shared in a rotational pool with other Coast Guard cutters.

Fire and smoke detection system. The fire and smoke detection systems on the 270-foot MECs are obsolete and require frequent maintenance to keep operational. The alarms are also wired to only indicate a "zone" in which smoke has been detected, not a specific compartment, requiring first responders to search for the fire when the alarm goes off.

Heating, ventilation, and air conditioning (HVAC) and condensation. According to engineering reports for the 210-foot and 270-foot MECs, crews experienced problems maintaining their HVAC systems and high levels of condensation. This leads to varying temperatures and high humidity throughout the ship, as well as mold present in living spaces such as berthing areas. This is both a safety and habitability issue for the crews.

While we toured an operational 210-foot MEC, crews pointed to instances of mold on piping throughout the ship. See figure 16 for an example of mold on piping that is directly above a bunk where crew sleeps.

Figure 16: Mold in Berthing Area of a 210-foot Medium Endurance Cutter

Source: GAO photo taken on site visit. | GAO-23-105805

Internet connectivity. Internet connectivity for many MECs is unreliable, with bandwidth too slow for modern computer programs. MECs are unable to use new applications for communication while underway, and completing day-to-day tasks and providing operational status updates can take an excessive amount of time.

SeaWatch system. SeaWatch is a command and control system that combines navigational and tactical, optical surveillance and communications into one situational awareness picture. In the engineering reports, multiple MEC crews reported frequent failure of various components of their SeaWatch systems, with the system crashing in heavy traffic areas. Loss of the SeaWatch system makes the MECs' means of navigation unreliable and affects their ability to safely navigate.

SPS-78 radar. SPS-78 is an automated tracking and collision warning system. In the engineering reports, MEC crews reported that their SPS-78 search radars are often unreliable at certain distances or for smaller vessels. This, along with the use of X-band antennae, limits their detection range, especially at night or in poor weather conditions.

Appendix III: Comments from the Department of Homeland Security

U.S. Department of Homeland Security
Washington, DC 20528

Homeland Security

May 22, 2023

Marie A. Mak
Director, Contracting and National Security Acquisitions
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Re: Management Response to Draft Report GAO-23-105805, "Offshore Patrol Cutter: Coast Guard Should Mature Technology and Design to Reduce Further Concurrency in Acquisition Phases"

Dear Ms. Mak:

Thank you for the opportunity to comment on this draft report. The U.S. Department of Homeland Security (DHS or the Department) appreciates the U.S. Government Accountability Office's (GAO) work in planning and conducting its review and issuing this report.

DHS leadership is pleased to note GAO's positive recognition that the Medium Endurance Cutters (MEC) generally met materiel and operational availability metrics at or above target levels from October 2019 and June 2022. Many of the MECs are undergoing a service life extension, which is helping to maintain these cutters by extending their service lives until the Offshore Patrol Cutters (OPC) are delivered and operational for the Coast Guard.

The draft report contained five recommendations for the Coast Guard, including three with which the Department concurs (Recommendations 1, 2, and 4) and two with which it non-concurs (Recommendations 3 and 5). Enclosed find our detailed response to each recommendation. DHS previously submitted technical comments addressing several accuracy, contextual, and other issues under a separate cover for GAO's consideration.

Again, thank you for the opportunity to review and comment on this draft report. Please feel free to contact me if you have any questions. We look forward to working with you again in the future.

Sincerely,

JIM H CRUMPACKER Digitally signed by JIM H CRUMPACKER
Date: 2023.05.22 15:58:33 -04'00'

JIM H. CRUMPACKER, CIA, CFE
Director
Departmental GAO-OIG Liaison Office

Enclosure

Enclosure: Management Response to Recommendations Contained in GAO-23-105805

GAO recommended that the Commandant of the Coast Guard:

Recommendation 1: Ensure OPC program officials develop a technology maturation plan for the davit prior to builder's trials. This plan should identify potential courses of action to address davit technical immaturity, including assessing technology alternatives should the current davit continue to face development challenges, and a date by which the Coast Guard will make a go/no-go decision to pursue such a technology alternative.

Response: Concur. The Coast Guard's technology maturation plan for the davit includes requiring a first article test (FAT) and endurance testing before American Bureau of Shipbuilding (ABS) approval and shipment to the shipyard. These tests will ensure the davit performance demonstrates attainment of Technical Readiness Level 6/7. If an operational davit is not provided by Eastern Shipbuilding Group by builder's trials, the Coast Guard will execute an alternative solution during OPC #1's post-delivery period. We request that GAO consider this recommendation resolved and closed, as implemented.

Recommendation 2: Ensure OPC program officials test an integrated prototype of the davit in a realistic environment prior to stage 1 builder's trials.

Response: Concur. ABS and the Coast Guard will witness the davit's FAT and enhanced endurance testing before having it shipped to the shipyard. FAT will expose the davit to realistic forces and loads to simulate Sea State 5. ABS must accept the davit to meet the contract's requirements. CG-9322, the OPC Program Office, is the responsible organization. Estimated Completion Date (ECD): December 29, 2023.

Recommendation 3: Ensure that the OPC stage 2 program follows shipbuilding leading practices by successfully demonstrating integrated prototypes of all critical technologies identified by the program or shipbuilder in a realistic environment no later than preliminary design review.

Response: Non-concur. The davit is the only critical technology identified for the OPC, and the shipbuilder selected a davit with a demonstrated pedigree in operational environments. CG-9322, supported by CG-459, the Ship Design Team, is working through preliminary design assessments with the shipbuilder and their davit sub-contractor. The entry and exit criteria at Preliminary Design Review (PDR) and Critical Design Review (CDR), including an enhanced focus on Contract Deliverable Requirements List (CDRL) reviews and enforcement of CDRL approvals, will ensure an iterative approach toward attaining davit design maturity. The FAT and endurance testing will demonstrate the integrated davit in a realistic environment. However, the FAT and endurance testing dates for OPC Stage 2 (which are not yet available) will occur *after* the PDR, which is the next major milestone and projected to occur during the third quarter of fiscal year 2023. We request that GAO

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consider this recommendation resolved and closed, as implemented.

Recommendation 4: Ensure that the Coast Guard Component Acquisition Executive, and prior to any contract awards for new shipbuilding programs, updates its acquisition policy to establish that all shipbuilding programs must complete the routing and design of major portions of all distributive systems that transit electricity, water, HVAC, and other utilities, as part of functional design prior to the start of lead ship construction.

Response: Concur. The requirement that all shipbuilding programs complete the functional design of major portions of distributive systems prior to the start of lead ship construction will be incorporated into the Assistant Program Executive Officer Surface Standard Operating Procedure (SOP) #932-23, "Design Maturity Parameters." ECD: July 31, 2023.

Recommendation 5: Ensure that the OPC stage 2 program achieves a sufficiently stable design prior to the start of lead ship construction. In line with shipbuilding leading practices, sufficiently stable design includes 100 percent completion of basic and functional design, including routing of major distributive systems and transitive components that affect multiple zones of the ship.

Response: Non-concur. The program does not agree that the definition of sufficiently stable design includes 100 percent completion of basic and functional design, including routing of major distributive systems and transitive components that affect multiple ship zones. The Program Management Officer defines sufficiently stable design as achievement of stable/high confidence in functional design, and enough production design and drawings to ensure production can continue without reliance on contractual drawings.

The Assistant Program Executive Officer Surface, SOP #932-23, was issued in August 2022 in accordance with GAO's feedback and following a Navy example. It was updated in April 2023 to incorporate GAO recommendations regarding technology readiness.

DHS and Coast Guard processes mandate an assessment of detail design progress and status at the PDR, CDR, and Production Readiness Review, respectively, to monitor progress toward attainment of 80 percent design maturity (defined as 95 percent of functional design and 70 percent of transitional detail design). Entry and exit criteria at these key milestone events will be used to ensure adequate design stability. Dates for these reviews will be determined during the OPC Stage 2 Integrated Baseline Review scheduled for June 2023.

We request that GAO consider this recommendation resolved and closed, as implemented.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

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